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PHYSICS ABSTRACTS

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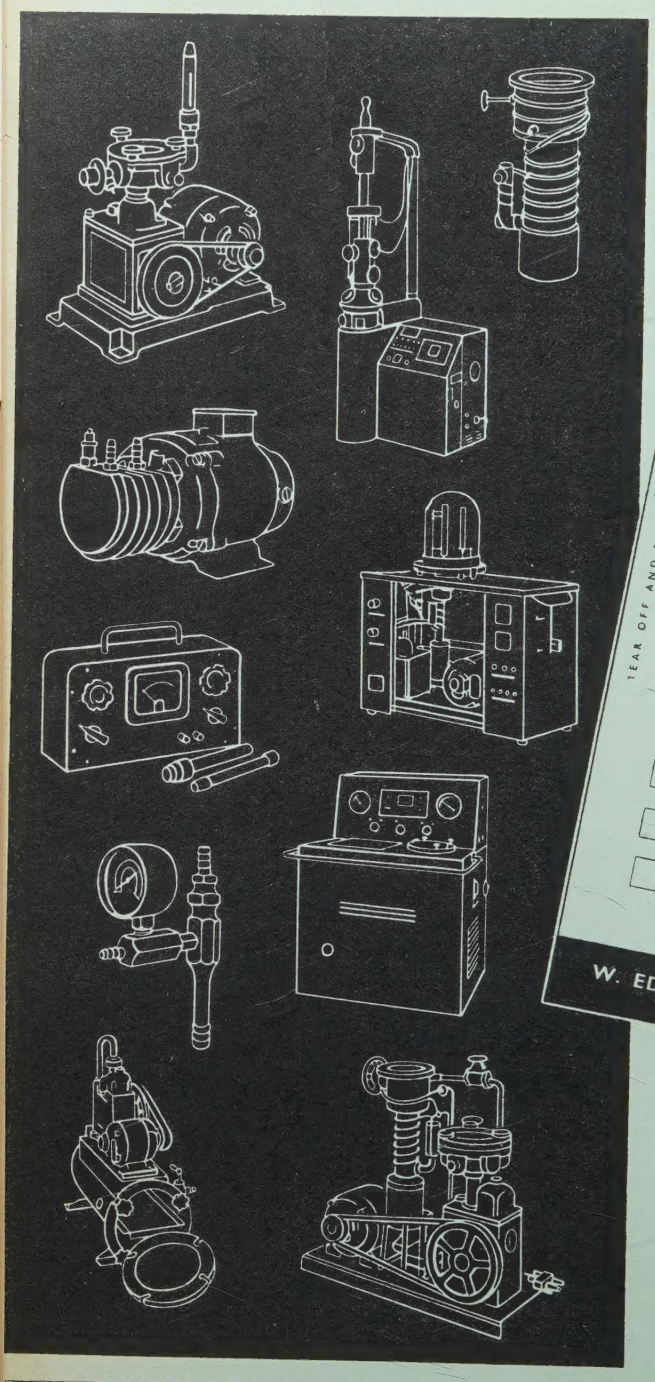

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MATHEMATICS 51

512.83

9224. A method of gradients for the calculation of the characteristic roots and vectors of a real symmetric matrix. M. R. HESTENES AND W. KARUSH. *J. Res. Nat. Bur. Stand., Wash.*, **47**, 45–61 (*July*, 1951).

517.9

9225. The application of relaxation methods to the solution of differential equations in three dimensions. I. Boundary value potential problems D. N. DE G. ALLEN AND S. C. R. DENNIS. *Quart. J. Mech. Appl. Math.*, **4**, 199–208 (*June*, 1951).

It is shown that provided the work is set out properly, there is no particular difficulty in the use of a three-dimensional network. As examples solutions are found for the steady temperature-distribution problem of Tranter [Abstr. 826 (1949)], and for the electric potential distribution inside a quadrant electrometer. A.

517.942.9

9226. A note on the initial excitation of linear systems. L. A. ZADEH. Letter in *J. Appl. Phys.*, **22**, 1216–17 (*Sept.*, 1951).

A previous result [Abstr. 5974 (1951)] gives the response $v(t)$ to a given input, when the specified initial values are those of $v(t)$ and its derivatives at $t = 0+$. This is now extended to the case where the initial values are at $t = 0-$. L. S. GODDARD

518.2

9227. Table of arctangents of rational numbers. J. TODD. *Nat. Bur. Stand. Appl. Math. Ser. No.* 11, 105 *pp.* (1951).

Arctan and Arccot m/n are given in radians to 12 decibels for $0 < m < n \leqslant 100$. In addition, a table gives a list of those integers n not exceeding 2 089 for which Arctan n is reducible and the corresponding complete reductions.

518.2

9228. Tables of $n!$ and $\Gamma(n + \frac{1}{2})$ for the first thousand values of n. H. E. SALZER. *Nat. Bur. Stand. Appl. Math. Ser. No.* 16, 10 *pp.* (1951).

The tables give $n!$ to 16, and $\Gamma(n + \frac{1}{2})$ to 8 significant figures.

518.5

9229. Functional description of the EDVAC. *Overseas Res. Rep.*, 230/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off Tech. Serv. Wash.*, *PB* 110330, *PB* 110331, *PB* 110332.

518.5 : 621.318.572 : 621.391

9230. Information theory and most efficient codings for communication or memory devices. L. BRILLOUIN. *J. Appl. Phys*, **22**, 1108–11 (*Sept.*, 1951).

Shannon's theorem about the capacity of a channel is discussed, and it is shown that the most efficient coding is the one yielding the most probable distribution of the code symbols. A specific rule is obtained for this most probable distribution. Most efficient coding is essential for communication channels or memory devices in large scale computers. A.

519.24 : 537.533.74 : 778.3

9231. Observations on the multiple scattering of ionizing particles in photographic emulsions. III. Statistics of the sampling distributions of second differences and the technique of overlapping cells. C. O'CEALLAIGH AND O. ROCHAT. *Phil. Mag.*, **42**, 1050–9 (*Sept.*, 1951).

For Pt II, see Abstr. 7941 (1951). Predictions based on a theoretical treatment of the problem of overlapping cells, are in satisfactory agreement with the results of experiment. They would indicate that the dispersions of the sampling distributions of certain statistics commonly used to estimate the scattering of particles, are almost independent of λ, the coefficient of overlap. The dispersions are found to differ but little from those of measurements based on a smaller number of non-overlapping cells which are shown to be independent in the sense of ordinary statistical theory of small samples. It is concluded that the advantage of employing the technique of overlap is inappreciable. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.38

9232. On a method of determining the irregularities of the pivots of an Askania–Bamberg reversible transit instrument. P.-M. DJURKOVIČ. *Bull. Astron., Paris*, **16** (*No.* 2) 131–5 (1951) *In French.*

Describes the measurement and calculation of the pivot errors. The method suggested has two advantages, (*a*) simple and easily acquired apparatus, (*b*) the errors are measured with the same objective as that used for star observations. E. G. MARTIN

522.44

9233. Principles of a new transit instrument. P. SÉMIROT. *Bull. Astron. Paris*, **16** (*No.* 2) 137–43 (1951) *In French.*

A new form of transit instrument where the telescope is fixed in the East–West direction. The light from a star falls upon a total reflection prism and then passes into a Wollaston prism, the emergent beam being then transmitted to the transit instrument. The theory of the instrument is given and methods for determining the several adjustments are described.

E. G. MARTIN

523.11 : 536.75

Increase of entropy in an infinite universe. *See Abstr.* 9435

523.112 : 539.17

Neutron-capture theory of element formation in an expanding universe. *See Abstr.* 9682

523.165

9234. A preliminary survey of the radio stars in the northern hemisphere. M. RYLE, F. G. SMITH AND B. ELSMORE. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 508–23 (1950).

Observations with an interferometer of large resolving power have made it possible to locate 50 discrete sources of radio waves or "radio stars" in the Northern Hemisphere; their positions and intensities (which cover a range of $7\frac{1}{2}$ in apparent magnitude) are given. The positions of the more intense radio stars can be determined with an accuracy of about 5 minutes of arc, but most of them can only be located to within 1°. The angular distribution of the radio stars, unlike that of the general background radiation, shows no concentration in the galactic plane; this result suggests either that they are at distances small compared with the dimensions of the galaxy, or that they are situated outside the galaxy. Whilst there is evidence that a few of the weakest radio stars represent the total "background" radiation of some of the nearest extra-galactic nebulae, it is concluded that the majority of the radio stars must be situated within the galaxy. Estimates of the relative intensities of the radio stars and of the background radiation have suggested that they are distributed throughout the galaxy with an average population density comparable with that of visual stars. Attempts to identify the radio stars with various types of visual body have been unsuccessful; it is therefore concluded that the radio star represents a hitherto unobserved type of stellar body, distributed widely throughout the galaxy, and one which is equally numerous in other spiral nebulae. A.

523.2

9235. On the evolution of the protoplanets. G. P. KUIPER. *Proc. Nat. Acad. Sci., Wash.*, **37**, 383–93 (*July*, 1951).

Continuing previous work [Abstr. 5014 (1951)] the dissolution of protoplanets into existing planets is now discussed. Ejection and evaporation processes are considered, and it is concluded that excess mass was lost, not by equatorial instability, but by approximately radial ejection of matter. The important contribution of solar radiation pressure to the processes of mass dispersal is emphasized. R. A. NEWING

523.4

9236. Internal constitution of large planets. N. A. KOZYREV. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 217–20 (1951) *In Russian.*

The low densities of large planets such as Jupiter indicate that, unlike the planets of the Earth group, the principal element in their formation is hydrogen. It is shown graphically that Jupiter, Saturn and Uranus are almost identical in this respect, while the Moon, Mercury and Mars have higher densities, and it appears probable that the Earth is unique in its group in having a nucleus of iron. Both theoretical conclusions and radiometric data indicate that Jupiter is in fact a hot planet, consisting of gas approaching the point at which the Boyle–Marryat law would be contravened. These high temperatures and the luminosity of heavenly bodies cannot be due to nuclear changes, and must therefore be regarded as purely stellar peculiarities, the internal energy of the Earth being most likely of the same nature, since it is doubtful whether it can be exhausted by the radioactivity of strata or gravitational differentiation. J. CLEUGH

523.43

9237. Interpretation of the polarization of light reflected by the different regions of the surface of the planet Mars. A. DOLLFUS. *C.R. Acad. Sci., Paris*, **233**, 467–9 (*Aug.* 6, 1951) *In French.*

Previous observations [Abstr. 2287 (1949)] have been extended, and the results are compared with polarization produced under known conditions. The polarization of light from the bright regions is analogous to that produced by reflection from powdered limonite; light from the dark regions resembles that reflected from small opaque granules (mineral, or perhaps microscopic plants), and differs from light reflected by extended vegetation. R. A. NEWING

523.59

9238. Photoelectric study of the zodiacal light. M. HURUHATA. *Publ. Astron. Soc. Japan*, **2** (*No.* 4) 156–71 (1951).

Photoelectric observations mainly with a blue-sensitive unit were carried out in 1945–49. Yearly variation of the intensity of the evening zodiacal light was studied first, finding that the intensity varies by the position of the comet Encke. The meteoric particles along the orbit of the comet seem to be the major source of the bright zodiacal light in autumn and spring. The observations of the polarization of the light confirm this. The zodiacal light in the solar corona is discussed in relation to the writer's theory about the source of the zodiacal light, concluding that the bright zodiacal light in autumn and spring cannot be prolonged to the F-corona, and that the red shift of Fraunhofer lines in the corona may be observable in convenient seasons of the year. A.

523.72/.75

9239. On the ultraviolet emission of the chromosphere. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **2** (*No.* 3) 102–12 (1951).

Radiation field and excitation inside the hydrogen chromosphere with very high electron temperatures have been treated. The ultraviolet and Lyman alpha radiations are emitted by the electron collisions inside the chromosphere. The main source of the ultraviolet emission is the chain of transitions: the collisional excitation from the ground state to the second state, succeeded by the photoelectric ionization by the absorption of the continuous Balmer radiation from the photosphere and subsequent recombination, rather than the direct collisional ionization and recombination. For the electron temperature $T_e = 35\,000$, the ultraviolet intensity amounts to $J \sim 10^9$. This corresponds to the Planck intensity for the temperature 13 000. The intensity of the Lyman alpha radiation is $J_\alpha \sim 10^7$. The ratio of the ion to the neutral atom is $N_e/N_1 \sim 10^5$. The optical thickness of the chromosphere is $\tau_1 \sim 0{\cdot}001$ for the ultraviolet radiation, and $\tau_{\alpha_1} \sim 10$ for the Lyman alpha radiation. For the electron temperature $T_e = 20\,000$, $J \sim 10^6$, $J_\alpha \sim 10^6$, $\tau_1 \sim 1$, $\tau_{\alpha_1} \sim 10^4$, $N_e/N_1 \sim 10^3$, and $N_2/N_1 \sim 10^{-4}$. A.

523.746

9240. Intensity variations in sunspots. R. ANANTHAKRISHNAN. Letter in *Nature, Lond.*, **168**, 291–2 (*Aug.* 18, 1951).

Spectrograms of the large sunspot of 1951 March 17–29 are reproduced, obtained at the Solar Physics Observatory at Kodaikanal, utilizing a solar image of 60 mm dia. formed by a 21 ft photo-visual lens; exposure times 1–3 sec. They show clearly that the spectrum of the umbra was bordered on either side by bright margins separating it from the penumbral spectra. Examination of older spectra subsequently revealed other cases where the inner edge of the penumbra is brighter than its outer edge. This is an interesting verification of Secchi's sunspot drawings of some 80 years ago, which in recent years were doubted, and attributed to contrast effects, by modern observers, who (working under less favourable climatic conditions) concluded that the total energy falls off continuously. The fact that most other spectra do not show this now established sharp intensity demarcation between umbra, penumbra and photosphere, is attributed to atmospheric unsteadiness causing wandering of the image on the spectrograph slit. A. BEER

523.77

9241. Technetium in the sun. C. E. MOORE. *Science*, **114**, 59–61 (*July* 20, 1951).

Lab. spectra of the rare element 43 by Meggers and Scribner are used to test its presence in the sun. Lines of Tc I are masked by other solar lines or are too weak to be detected, but Tc II is shown to be possibly present. D. L. EDWARDS

523.774

9242. Observation of the limb effect of faint Fraunhofer lines. Z. SUEMOTO. *Publ. Astron. Soc. Japan*, **2** (*No.* 3) 126–32 (1951).

Limb centre variations of some 50 faint Fraunhofer lines were measured at $\cos\theta = 1{\cdot}0$, $0{\cdot}8$, $0{\cdot}6$, $0{\cdot}4$, $0{\cdot}3$ and $0{\cdot}2$, and it was found that, statistically, lines with η decreasing more rapidly with depth show stronger limb strengthening as compared with those with η of slower decrease. Limb centre variations were calculated for 3 types of η variation at λ 5 100 Å, and they were compared with those measured by Adam. A.

523.775

9243. On the excitation of helium in the chromosphere. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **2** (*No.* 3) 113–21 (1951).

The chromospheric He spectrum has been investigated under the assumption of the kinetic temperature 35 000 and the H/He ratio 5 : 1. He is ionized by electron collision and the relative concentration becomes He: He^+: $He^{++} = 0{\cdot}25 : 1 : 0{\cdot}07$. The chromosphere is very opaque for the ionizing and resonance radiation of He and He^+. And mean intensities of the resonance lines of He and He^+ become comparable with the Planck radiation at 35 000 inside the layer. As a consequence, the population of the excited levels becomes very large both for He and He^+, so that the strong HeI and HeII absorption lines are predicted in the ordinary Fraunhofer spectrum. The high population also predicts very strong emission lines of HeI and HeII in the flash spectrum, in obvious contradiction with observation. From the present calculation it is concluded that the kinetic temperature of the chromosphere should not exceed 10 000, so far as the HeI and HeII spectra are concerned. The temperature estimation of the chromosphere is discussed briefly. A.

523.775

9244. Line contours in the anomalous regions of the sun. Z. SUEMOTO. *Publ. Astron. Soc. Japan*, **2** (*No.* 4) 137–49 (1951).

Some three hundred standardized spectra have been accumulated, using a self-registering microphotometer recently constructed. Contours of H_ε, H and K lines in flares, flocculi and flocculi over sunspots were studied. In one of the flare spectra, H_ε line is well fitted by a Doppler contour with half-width $0{\cdot}44$ Å, corresponding to an electron temperature of 70 000°, while H and K lines are fitted by the one which is the superposition of the natural damping wing and the Doppler core with its half-width $0{\cdot}070$ Å. Analysis of K line contour in flocculi yields the Doppler core of the same width, suggesting that the layer responsible for the emission has an electron temperature of the order 70 000°. The enhanced layer extends from the base of the chromosphere up to 10 000 km for normal flocculi, but the layer seems to be lifted by several thousand kilometers over sunspots. Vertical extension of the flare layer must be much higher than that of flocculi. A.

523.82

9245. Magnitudes of bright stars in the E regions observed by the Fabry method. A. W. J. COUSINS. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 531–47 (1950).

Describes the Fabry photometer attached to the Cape Astrographic Telescope and its use to determine photographic, photovisual and "blue" magnitudes of the brighter stars in the Harvard E Regions. The systematic errors affecting the method are discussed and accidental errors are analysed. The Fabry magnitudes have been compared with one another (Pg and blue) and with magnitudes obtained with the Cape Photometric Cameras. The Fabry colours have been compared with colours measured photoelectrically. The colour corrections are linear. It is concluded that standard magnitudes should be determined with a precision of at least $\pm 0^m{\cdot}02$ but that there is not much to be gained by pressing the accuracy beyond $\pm 0^m{\cdot}01$. A final section discusses the relative merits of the photoelectric and Fabry methods. A.

523.838

9246. The importance of rotation in stellar evolution. P. A. SWEET. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 548–58 (1950).

Eddington's assessment of the rate of circulation in meridian planes in the Sun, produced by its rotation, is reviewed, using a first-order perturbation theory. The resulting velocity is found to be of the order of 10^{-10} cm/sec, as compared with Eddington's figure of 2×10^{-4} cm/sec, a reduction of importance when considering the amount of mixing of material in the Sun during its lifetime. The theory is applied to stars in general, and the equatorial rotation velocity necessary to provide a significant rate of stirring in a star is found in terms of its magnitude and effective

temperature. These rotation rates are found to lie within the range actually observed for early-type stars, but are in excess of those for the later types. In view of the widely held opinion that giants are stars with non-uniform composition, the distribution of rotation rates among the stars thus assumes an added interest. The rotation rate can similarly govern the possibility of local exhaustion of hydrogen in the core, with its consequent effects on evolution. A.

523.852.3 : 530.12

9247. Two-colour indices and general relativity. G. C. McVittie. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 590–4 (1950).

When the system of the extra-galactic nebulae is represented by a homogeneous model of general relativity, it is shown that the formula for the two-colour index measured by Stebbins and Whitford can be established theoretically. Comparison of this theory with the observations leads to the conclusion that the interpretation of the reddening of remote nebulae as a time-effect cannot be regarded as proven because of the paucity of data, but that there is a strong presumption in its favour. A.

523.875

9248. On the interpretation of the Hertzsprung–Russell diagram. H. Bondi. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 595–606 (1950).

A general discussion of laws of energy generation and opacity is given, together with a brief account of stellar evolution based on the view that stars consist almost entirely of H and He. The Hertzsprung–Russell diagram is drawn, using mainly Kuiper's data on the nearest stars and also his estimates of surface temperatures and bolometric corrections. It is shown that this diagram strongly indicates that a switch of the law of energy generation occurs for stars of a luminosity about one-sixth that of the Sun. The brighter stars draw their energy from a highly temperature-sensitive process which is probably the Bethe cycle. The fainter stars draw their energy from a much less temperature-dependent process the proton-proton reaction (presumably). Consideration of the Sun's central temperature shows that the astrophysical data definitely contradict the earlier estimates for the critical temperature of the Bethe cycle and tend to show that this temperature may even be slightly lower than the more recent experiments indicate. A.

523.877

9249. Transport of heat and matter by convection in stars. E. J. Öpik. *Mon. Not. Roy. Astron. Soc.* **110** (*No.* 6) 559–89 (1950).

A quantitative analysis of the transport of heat in thermal convection is developed. An essential improvement consists in allowing for the lateral exchange of heat between the turbulent elements. The analysis is applied to the case of a medium with an originally stable stratification by molecular weight, and to Coriolis stratification of convection itself produced by rotation. The start of small-scale convection may be prevented by the radiative exchange of heat. As compared with radiation, viscosity is an insignificant factor in impeding thermal convection. The mixing efficiency, or the transport of matter by thermal convection in a stratified medium is investigated. It is strongly influenced by rotation. The propagation of convection in a metastable "super-adiabatic" layer is investigated. The bearing of these results upon a theory of the ice ages is considered. A.

523.877

9250. Theory of the formation of stars. A. I. Lebedinskiĭ. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 1) 41–4 (1951) *In Russian.*

Three observed facts, (1) that almost all subsystems of massive stars disperse at lower speed than those of non-massive stars, (2) that most accumulations of stars are in process of dispersion, not reinforcement, (3) that the limit of mass of dispersing stars is reached when radiation energy equals gaseous energy, lead to the hypothesis that stars of the greatest observed mass, apart from certain giant stars, the energies of which cannot at present be observed, are not in equilibrium but must dissolve, by a series of multiple condensations, into new stars of smaller mass. J. CLEUGH

523.877

9251. Largest possible masses of single stars and formation of multiple systems. A. I. Lebedinskiĭ. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 415–18 (1951) *In Russian.*

The author's theory [previous Abstr.] of the essential instability of exceptionally massive stars, with excess of radiation over gaseous heat energy, causing them to form multiple systems of stars of smaller mass, is here supported by a mathematical demonstration, taken to a numerical coefficient near to unity, that the decisive figure of mass at which fission of a star sets in is reached when gaseous and radiation energies within a star achieve parity.

J. CLEUGH

526.72

9252. Elasticity corrections for pendulums used in the absolute measurement of gravity. A. R. Curtis. *Mon. Not. Roy. Astron. Soc., Geophys Suppl.*, **6**, 159–62 (*April*, 1951).

The corrections for bending and stretching of a pendulum, used for making an absolute determination of gravity, are obtained by a simple process depending on the equation of angular momentum, the results agreeing with those recently given by Jeffreys. The source of error in Clark's work is pointed out, and also an error in Jeffreys' which has no effect on the result.

A.

PHYSICS 53

53

9253. Suggestions for the improvement of physics teaching in colleges and universities. G. W. Hazzard. *Amer. J. Phys.*, **19**, 374–8 (*Sept.*, 1951).

Possible defects of current physical science and physics courses for non-science students are discussed. A solution based on the desirability of common intellectual experience for all first-year college students is proposed. Emphasis is laid on the necessity for creative laboratory experience, informal discussion in

small classes, and intensive rather than extensive coverage of material for student enjoyment and appreciation of science. A.

53

9254. Some reflections on the teaching of physics. J. W. HORNBECK. *Amer. J. Phys.*, **19,** 412–15 (*Oct.*, 1951).

Response of the recipient of the Oersted Medal of the American Association of Physics Teachers at the ceremony of presentation. The teaching of physics in a small liberal arts college is discussed, and the values of a liberal education are stressed. A.

53.08

9255. Measure for measure: some problems and paradoxes of precision. F. B. SILSBEE. *J. Wash. Acad. Sci.*, **41,** 213–26 (*July*, 1951).

Deals mainly, and in very general terms, with examples from the physical sciences. The classification of scales of measurement, temperature scales, logarithmic scales, the measurement of colour and electrical energy, systems of units with particular reference to the Giorgi and MKSA systems of electrical units and the classification of standards are briefly discussed. S. WEINTROUB

53.081.1 : 541.183

The gibbs—a rational unit for adsorption. *See Abstr.* 9792

53.081.6

9256. A four-dimensional atomistic measure system leading to a natural classification of basic physical constants. E. I. BODEA. *An. Acad. Brasil. Cienc.*, **23,** 73–90 (1951).

The 4 universal and invariant constants, Maxwell's velocity of electromagnetic waves *in vacuo c*, Compton's frequency ν, the electronic charge e and Bohr's magneton m are chosen as basic units and the principle of dimensional coherence used to derive from Kalantaroff's LTQϕ system [*Gen. Elect. Rev.*, *No.* 25 (1929)] a rational system of natural atomistic units. Using this system it is shown that all basic physical constants can be expressed in terms of the 4 nos: 1; $68 \cdot 6 = \frac{1}{2}(137 \cdot 2)$, Sommerfeld's fine structure constant; 1839, the ratio of the proton to electron mass at rest; and $1 \cdot 936 \times 10^{46}$ for gravitation. S. WEINTROUB

53.087.6

9257. An automatic chart plotter for lecture room demonstrations. A. O. NIER AND R. B. THORNESS. *Amer. J. Phys.*, **19,** 416–19 (*Oct.*, 1951).

A recording millivoltmeter is described which gives a record sufficiently large and distinct to be seen by a large lecture audience. The device is useful for showing lecture room demonstrations in which currents or voltages vary with time and the audience needs a record to help appreciate the significance of the experiment. By means of connections to research apparatus in another part of the building, one may often perform actual experiments in front of a large class. A.

FUNDAMENTALS 530.1

530.1 : 538.11

9258. On a generalization of Wilson's hypothesis. G. LUCHAK. Letter in *Phil. Mag.*, **42,** 807–8 (*July*, 1951).

It is asserted that Papapetrou's generalization [Abstr. 4678 (1950)] is not relativistically invariant, and does not reduce uniquely to Wilson's hypothesis concerning the origin of the geomagnetic field. R. A. NEWING

530.12

9259. Spinning test-particles in general relativity. I. A. PAPAPETROU. *Proc. Roy. Soc. A*, **209,** 248–58 (*Oct.* 23, 1951).

A method for the derivation of the equations of motion of test particles in a given gravitational field is developed. The equations of motion of spinning test particles are derived. The transformation properties are discussed and the equations of motion are written in a covariant form. A.

530.12

9260. Spinning test-particles in general relativity. II. E. CORINALDESI AND A. PAPAPETROU. *Proc. Roy. Soc. A*, **209,** 259–68 (*Oct.* 23, 1951).

The equations of motion for spinning test particles are discussed for particles characterized by the condition $S^{i4} = 0$. A.

530.12 : 531.1

9261. The fundamentals of relativistic kinematics. D. BLANUŠA. *Glasn. Mat.-fiz. Astron.*, **6** (*No.* 1–2) 1–32 (1951). *In Croatian. German summary* (10 *pp*).

From five kinematical assumptions (existence of inertial systems, isotropy of space, Newton's first axiom, homogeneity of time, relativity principle) a chain of deduction leads to a projective relation connecting two inertial systems, which contains the Lorentz and Galilean transformations as special cases. R. H. DALITZ

530.12 : 531.18

9262. The clock paradox in relativity theory. H. E. IVES. Letter in *Nature, Lond.*, **168,** 246 (*Aug.* 11, 1951).

[See Abstr. 6018 (1951)]. A discussion of clocks which reverse their direction of motion is made in terms of an auxiliary moving clock to which the epochs of the original clocks are communicated on passing. R. A. NEWING

530.145

9263. On the mathematical frame of the theory of elementary particles. W. HEISENBERG. *Commun. Pure Appl. Math.*, **4,** 15–22 (*June*, 1951).

Surveys the author's theory of elementary particles [Abstr. 835 (1951)] with particular comments on the failure of the proposed S-matrix to satisfy the group-property, the possibility of non-causal processes and comparison with other theories modifying space-time structure at small distances. R. H. DALITZ

530.145 : 537.13

9264. Physical applications of the resolvent operators. I. On the mathematical formalism of Feynman's theory of the positron. M. SCHÖNBERG. *Nuovo Cim.*, **8,** 651–82 (*Sept.*, 1951).

The resolvent operators of the theory of linear functional equations are applied to the quantum formalism in general and more specially to the Feynman formulation of the hole theory. A generalization of the resolvent operators is given in order to treat problems with time dependent Hamiltonians. It is shown that Feynman's formulation amounts to considering divergent waves for the positive kinetic

energies and convergent waves for the negative kinetic energies, in the propagation kernel. Expansions of the propagation kernels are derived from the resolvent, without using Feynman's integral equation, which leads to difficulties. A relativistically invariant resolvent is defined in the theory of quantized interacting fields. An operator related to the resolvent describes a new kind of collision which can be used in the theory of the ground state of atomic nuclei. A.

530.145

9265. On the quantum theory of fields. I. G. WATAGHIN. Letter in *Nuovo Cim.*, **8**, 592–4 (*Aug.*, 1951).

Discusses a non-local S-matrix theory in which the interaction operator is a function of invariants formed from the relative co-ordinates, the total momentum and the momentum transfer, such that the theory becomes the conventional one for separations exceeding a certain value. R. H. DALITZ

530.145

9266. Erratum: Quantum statistics of fields. A. E. SCHEIDEGGER AND C. D. MCKAY. Letter in *Phys. Rev.*, **83**, 1263 (*Sept.* 15, 1951).

See Abstr. 6732 (1951).

530.145

9267. Charge fluctuations in quantum electrodynamics. E. CORINALDESI. Letter in *Nuovo Cim.*, **8**, 494–7 (*July*, 1951).

The vacuum expectation value of the square of the charge within a given volume is calculated using the charge density operators of the scalar and vector fields, when the "smearing" of the boundary has dimension $< \hbar/mc$. R. H. DALITZ

530.145

9268. An operator calculus having applications in quantum electrodynamics. R. P. FEYNMAN. *Phys. Rev.*, **84**, 108–28 (*Oct.* 1, 1951).

An alteration in the notation used to indicate the order of operation of noncommuting quantities is suggested. Instead of the order being defined by the position on the paper, an ordering subscript is introduced so that $A_sB_{s'}$ means AB or BA depending on whether s exceeds s' or vice versa. Then A_s can be handled as though it were an ordinary numerical function of s. An increase in ease of manipulating some operator expressions results. Connection to the theory of functionals is discussed in an appendix. Illustrative applications to quantum mechanics are made. In quantum electrodynamics it permits a simple formal understanding of the interrelation of the various present day theoretical formulations. The operator expression of the Dirac equation is related to the author's previous description of positrons. An attempt is made to interpret the operator ordering parameter in this case as a fifth coordinate variable in an extended Dirac equation. Fock's parametrization, discussed in an appendix, seems to be easier to interpret. In the last section a summary of the numerical constants appearing in formulas for transition probabilities is given. A.

530.145

9269. Radiation corrections in quantum electrodynamics. A. D. GALANIN. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 229–32 (1951) *In Russian.*

Rules for obtaining the matrix elements of any transition of a system of interacting electron and photon fields can be obtained without Schwinger's exchange effect representation. J. JACOBS

530.145

9270. Nuclear two-body interactions. J. D. JACKSON. *Nat. Res. Coun. Can., Publ., No.* 2395, 50 *pp.* (1950).

The text of four lectures surveying theory and experiment on the nuclear two-body problem, both at low energies (shape-independent approximation) and at high energies. R. H. DALITZ

530.145

9271. Anticommutating matrices in meson theory. A. BORGARDT. *Dokl. Akad. Nauk. SSSR*, **78** (*No.* 6) 1113–14 (1951) *In Russian.*

Discusses Kemmer's theory [*Proc. Roy. Soc. A*, **173**, 91 (1939)]. The fundamental equations are put into a form which looks amenable to re-normalization procedures. E. P. GEORGE

530.145

9272. General theory of damping phenomena for non-stationary processes. I. Fundamentals, and connection with the S-matrix formalism. E. ARNOUS AND S. ZIENAU. *Helv. Phys. Acta*, **24** (*No.* 3) 279–95 (1951) *In German.*

The damping theory of discrete states due to Heitler and Ma [Abstr. 3750 (1950)] is adapted to the positron theory in an operator form. A formal solution of the integral equation is obtained and an operator defined, which combines the damping constants and the elements of the collision operator, when written in energy representation. The connection with the S-matrix formalism is discussed.

R. H. DALITZ

530.145

9273. On the reciprocal field theory. J. RAYSKI. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 657–8 (*July*, 1951).

A non-local field theory satisfying Born's reciprocity principle is set up describing interaction between a complex and a real scalar field, its basic equations being integral equations from which an S-matrix may be obtained by standard methods. This S-matrix is at once free from divergences.

R. H. DALITZ

530.145

9274. Some remarks on the use of β-formalism of the meson field for nuclear interactions. VACHASPATI. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 659–60 (*July*, 1951).

The general β-matrix formalism of Harish-Chandra [Abstr. 210 (1947)] for description of meson fields needs further specification (given here) to ensure positive definiteness of the Hamiltonian and to avoid occurrence of negative probabilities. R. H. DALITZ

530.145 : 537.533.8

Bremsstrahlung of particles having a magnetic moment as well as spin. *See Abstr.* 9529

530.145

9275. On the theory of the formation of many particles in one act. I. POMERANCHUK. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 5) 889–91 (1951) *In Russian.*

Develops Fermi's theory [Abstr. 3336 (1951)].

The strong interactions of protons and π-mesons causes the relevant volume in phase-space to expand rapidly until particle separations approximately equal the range of nuclear forces. This has an important effect on the expected number of shower particles, and modified formulae are given. Furthermore, the rapid expansion gives rise to a large drop in temperature, which renders improbable the production of nucleon pairs. E. P. GEORGE

530.145

9276. On the Schrödinger "Zittern" of the de Broglie particle with spin 1, of meson type. V. S. VRKLJAN. *Nuovo Cim.*, **8**, 369–73 (*June*, 1951) *In German.*

The "Zitterbewegung" phenomena analogous to that for the Dirac particles, is discussed for the spin 1 particle, in the representations of this theory given by the author [Abstr. 7743 (1950)] and by de Broglie.

530.145

9277. The non-relativistic second approximation of Born collision theory for the Yukawa potential. K. F. BORN AND E. HÜCKEL. Note in *Naturwissenschaften*, **38** (*No.* 13) 302 (1950) *In German.*

The calculation of the second Born approximation for non-relativistic scattering by a Yukawa potential, formulated by Moller [*Z. Phys.*, **66** (*No.* 7–8) 513–32 (1930)] is here completed. R. H. DALITZ

530.145

9278. A scattering approximation. A. L. LATTER. Letter in *Phys. Rev.*, **83**, 1056–7 (*Sept.* 1, 1951).

An approximation method for treating the scattering of a plane wave by a square well potential is described. The results obtained by this method in a particular case are compared graphically with the exact solution, and that obtained by the Born approximation.

J. HUGHES

530.145

9279. Nonlinear meson theory of nuclear forces. I. Neutral scalar mesons with point-contact repulsion. L. I. SCHIFF. *Phys. Rev.*, **84**, 1–9 (*Oct.* 1, 1951).

Develops an attempt to account for nuclear saturation and shell structure in terms of many-body forces that are derived from mesons that obey a nonlinear wave equation. Classical field theory is used, and in some cases the practical difficulties of obtaining numerical answers are reduced by employing a variation method. Apart from a cut-off, which appears in this particular form of the theory but could be eliminated, there are two parameters in the theory; they can be chosen so that nuclear matter has a stable density equal to the observed value, and a variational binding energy equal to 42% of the observed value, thus approximately accounting for saturation. The two-nucleon interaction has the observed order of magnitude in empty space, and is greatly reduced within nuclei. This suppression of two-body interactions in favour of the interaction of each nucleon with the average nucleon density in heavy nuclei may account for the independent-particle model and hence for shell structure. Although the theory does not account for magnetic moments, it indicates that a more realistic version (for example, a nonlinear pseudoscalar theory) may predict a reduction of the anomalous magnetic moments of nucleons within nuclei. According to a recent suggestion of Bloch, this could account for the deviations of the magnetic moments of even-odd nuclei from the Schmidt lines. The nonlinearity also has the consequence that mesons are scattered from nuclei as though by a strong repulsive potential. The relation of this effect to current observations on interactions between mesons and nuclei is briefly discussed. A.

530.145

9280. Nonlinear meson theory of nuclear forces. II. Nonlinearity in the meson–nucleon coupling. L. I. SCHIFF. *Phys. Rev.*, **84**, 10–11 (*Oct.* 1, 1951).

The possibility of accounting for nuclear saturation by means of classical neutral scalar mesons that are coupled nonlinearly to the nucleons is investigated. It is shown that the interaction energy of an aggregate of nucleons is the same as in the usual linear theory if the nucleons are regarded as point sources. The theory does not, therefore, lead to saturation. A.

530.145

9281. A nomographic representation of the collision between two particles of atomic dimensions. F. MARIANI. *Nuovo Cim.*, **8**, 297–300 (*May*, 1951) *In Italian.*

A nomogram is given relating the angles of scattering and the momenta and energies of two particles after a relativistic collision, when one particle is initially at rest. R. H. DALITZ

530.145

9282. On perturbation theory in quantum mechanics. II. Continuous and mixed spectra. M. SCHÖNBERG. *Nuovo Cim.*, **8**, 403–31 (*June*, 1951) *In French.*

The author's methods for discrete states [Abstr. 7555 [1951)] are generalized to continuous and mixed spectra, both for systems of particles and quantized fields. In the continuous spectrum, the usual perturbation calculations do not correctly determine the self-energy of the state owing to ambiguity in the correspondence between perturbed and unperturbed levels, but, for this case, a modified form of Heitler–Peng equation is given. In the development of the operator connecting the state function at different times, elimination of the secular terms is shown to be possible. R. H. DALITZ

530.145 : 539.165

9283. Relativistic wave-functions and *K*-capture for a modified Coulomb field. I. MALCOLM AND C. STRACHAN. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 610–16 (1951).

Normalized Dirac wave-functions are obtained for a spherical potential field, constant for $r < R$, joining with a Coulomb field beyond. These are used to calculate the ratio of *K*-capture to e^+-emission.

R. H. DALITZ

530.145.6

9284. On the approximate calculation of eigenvalues of a Schrödinger equation. H. J. MAEHLY. *Nuovo Cim.*, **8**, 466–8 (*July*, 1951).

A method similar to that of Kohn [Abstr. 2409 (1947)] is proposed for calculation of limits to eigenvalues of a stationary Schrödinger equation, parti-

cularly for the eigen-potentials of given form corresponding to given binding energy or scattering phase.
R. H. DALITZ

530.162

9285. On the distribution laws of "numbers of completion" in quantum statistics. A. Ya. Khinchin. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 461–3 (1951) *In Russian.*

Boundary laws of distribution are sought instead of the usual average and dispersion values. A system of equal particles is considered, obeying Maxwell–Boltzmann, Bose–Einstein or Fermi–Dirac statistics. Expressions are sought which retain the same relationships as the number, energy and volume of the particles become ∞.
J. JACOBS

530.162 : 512.9

9286. The statistics of Bose–Einstein and Fermi–Dirac from the tensor point of view. P. K. Raševskiĭ. *Trudy Sem. Vektor. Tenzor. Analizu*, **7**, 362–80 (1949) *In Russian.*

In the usual presentations of the quantum theory of an ensemble of identical particles the tensor point of view is commonly not preserved throughout. The author claims that if the tensor point of view is retained throughout, the calculations are both simpler, and more easily interpreted. Mathematical sections on the properties of tensors are followed by explicit applications of tensors to quantum theory.
MATH. REVIEWS

530.162 : 532.511

Statistical mechanical theory of transport processes. Quantum hydrodynamics. *See Abstr.* 9297

530.162 : 536.7

Formalism of thermodynamic fluctuation theory. *See Abstr.* 9434

530.162 : 536.7

9287. Partition theory and thermodynamics of multidimensional oscillator assemblies. V. S. Nanda. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 591–601 (1951).

The connection between thermodynamics and the partition functions of the theory of numbers which has already been established and shown to be valid for non-integral powers of integers [see Abstr. 2397 (1951)] is extended to thermodynamic assemblies of two- and three-dimensional oscillators.
T. C. TOYE

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.01 : 538.3

9288, Universal mechanics and Hamilton's quaternions. O. F. Fischer. *Stockholm, Axion Institute* (1951) 356 *pp.*

This book attempts to unify physics, as far as the notations used in various branches are concerned, by using quaternions. After summarizing vector analysis, quaternions are introduced and applied to mechanics and electromagnetism. The algebraic outlook resembles Hamilton's in naïvety, which is probably an advantage. Special and general relativity are summarized, and Einstein's 1950 theory is described in $3\frac{1}{2}$ pages. Clifford's numbers, or *E*-numbers, are considered as "double quaternions," and some of Eddington's "Fundamental Theory" is discussed. This discussion is uncritical of the physical aspects, but remarks that, instead of rejection, "It would be more useful to science to give careful thought. . . . And then attempt to clear up what is dubious." Some description is also given of Küssner's "Principia Physica," including his combinatorial theory of arithmetical invariants of mechanical systems.
C. W. KILMISTER

531.221.8

9289. The deflection of a cable due to a single point load. E. Markland. *Phil. Mag.*, **42**, 990–6 (*Sept.*, 1951).

A method is given for calculating the deflected shape of a uniform inextensible cable supported with each end at the same level, when a small point load is placed anywhere along the cable. The analytical treatment is straightforward and a method of successive approximations for the numerical solution of the equations is suggested. Results have been computed for the case of span to sag ratio of 10 and ratio of point load to cable weight of 0·1, and are compared with experimental values.
A.

531.224

9290. The influence of compressibility in elastic-plastic bending. J. W. Craggs. *Quart. J. Mech. Appl. Math.*, **4**, 241–7 (*June*, 1951).

In the classical theory of bending of a uniform beam by terminal couples all stress components except the longitudinal one are neglected. This assumption is shown to be incorrect for an elastic-plastic material unless it is incompressible and the magnitude of the hitherto neglected stress components is estimated by finding those arising in a simpler elastic-plastic problem of the same nature.
A.

531.231

9291. Moment of inertia experiment. W. L. Erickson. *Amer. J. Phys.*, **19**, 401–3 (*Oct.*, 1951).

This paper describes a laboratory experiment for determining moment of inertia in which the emphasis is on (1) a relatively high degree of accuracy; (2) useful application of several of the important principles of mechanics; and (3) improved instrumentation to attain the desired accuracy and still give time in the laboratory period for the student to explore the details and implications of the experiment.
A.

MECHANICAL MEASUREMENTS 531.7

531.752

9292. Adaptation of a chemical balance for precision weighing. A. A. Hills. *Canad. J. Phys.*, **29**, 245–50 (*May*, 1951).

The alterations made in a relatively cheap Sartorius analytical balance to produce a balance of sensitivity ranging from 0·124 mg per double cm division at zero load to 0·177 at full load of 200 g are described. The accuracy of weighing was determined by using 6 nominal 100 g weights and weighing these one

against the other in all possible pairs using a Gauss exchange. The results are tabulated. S. WEINTROUB

MECHANICS OF FLUIDS 532

532.13

9293. Theories of viscosity applied to ionic liquids. B. S. HARRAP AND E. HEYMANN. *Chem. Rev.*, **48**, 45–67 (*Feb.*, 1951).

The main rough viscosity theories are reviewed in the light of new data on 12 molten salts. The Batchinski–Macleod type of formula, $\eta = B/(v - b)$, is obeyed quite well and the B values are consistent with the view that B is proportional to the size of the flow unit. A similar result, $\rho = A/(v - b')$, holds for the resistivity. Eyring's equation, $d\ln(v\eta)/d(1/T) = T\ln(v\eta/hN)$, is not well satisfied. Further ideas of Eyring and of Grunberg and Nissan are examined with the help of collected data on ΔE_{visc}, ΔE_{vap}, ΔH_{fus} and the "work of cohesion," $W_c = 4{\cdot}78 \times 10^{-8}\gamma V^{2/3}N^{1/3}$. In most comparisons $CdCl_2$ appears as exceptional because of complex formation in the liquid state. AgCl is also exceptional, but the reason for this is not known. The viscosities and the values of ΔE_{visc} are given for a number of ionic mixtures—particularly for those whose molar volumes are linear functions of composition. For the latter class, Macleod's expression for the viscosity of the mixture is well verified. 50 references. R. O. DAVIES

532.13 : 532.77

9294. Viscosity of sodium thymonucleate. S. BASU. Letter in *Nature, Lond.*, **168**, 341–2 (*Aug.* 25, 1951).

It has been found that the reduced-viscosity/dilution graphs of aqueous solutions of sodium thymonucleate are similar to those of polyelectrolytes. F. LACHMAN

532.137

9295. The measurement of the flow properties of a pseudoplastic with a concentric cylinder viscometer. C. G. LINDQUIST AND W. C. SIERICHS. *J. Coll. Sci.*, **6**, 33–41 (*Feb.*, 1951).

The rate of shear across the annular gap tends to a constant as the clearance approaches zero. Using inner cylinders of different radii and keeping the shear stress at either the inner or outer cylinder wall constant, the shear stress rate of shear curves can be extrapolated. Curves for 5% methyl cellulose are given. J. E. CAFFYN

532.51

9296. On a fluid motion with a spherical boundary. R. BALLABH. *Proc. Nat. Inst. Sci. India*, **17**, 123–6 (*March–April*, 1951).

The author has previously derived the general conditions under which one fluid motion is superposable upon another so that the velocity of the resultant flow is the vector sum of the separate flows [*Proc. Benares Math. Soc., II*, 69–79 (1940)]. Now, he discusses general types of flows, in viscous or non-viscous fluids, superposable upon a constant flow having velocity components $U, 0, 0$, the fluid being bounded by a sphere of finite radius. The velocity components u, v, w of a fluid motion, of which the vortex lines are circles about the x axis, and which is superposable upon the motion $U, 0, 0$, are shown to be solutions of the equations $\Delta^2 u = 2F(Y) + 2YF'(Y)$, and $\Delta^2(v,w) = 0$, where $zF(Y) = \partial u/\partial z - \partial w/\partial x = \eta$, and $-yF(Y) = \partial v/\partial x - \partial u/\partial y = \xi$. An exact solution of the equations of motion of a viscous fluid within a spherical boundary is derived by applying Lamb's conditions of integrability of the equations.

J. S. G. THOMAS

532.511 : 530.162

9297. The statistical mechanical theory of transport processes. V. Quantum hydrodynamics. J. H. IRVING and R. W. ZWANZIG. *J. Chem. Phys.*, **19**, 1173–80 (*Sept.*, 1951).

For Pt IV, see Abstr. 7764 (1950). This paper is concerned with certain extensions of a formal technique devised by Wigner for handling problems in quantum-statistical mechanics, especially to problems in quantum-mechanical transport processes. The approach is to find the closest possible analogy between classical and quantum-statistical mechanics, so that the extensive work in classical statistical mechanics can be utilized. This analogy is attained with the Wigner distribution function, with which averages of dynamical variables in quantum mechanics may be calculated by integrations in phase space. Some basic properties of distribution functions in classical statistical mechanics are first stated, and then the corresponding properties of the density matrix in quantum mechanics. The Wigner distribution function is shown to have the desired averaging properties, and the analogue of the Liouville equation satisfied by this function is obtained. The analogue is derived in reduced phase space, and the equations of hydrodynamics are then obtained from quantum statistical mechanics. A.

532.517

9298. The motion of an elastico-viscous liquid contained between coaxial cylinders. I. J. G. OLDROYD. *Quart. J. Mech. Appl. Math.*, **4**, 271–82 (*Sept.*, 1951).

The theory of periodic and steady states of motion of the liquid is considered, when the viscous and elastic properties of the material at small rates of shear are measured by three constants, a viscosity coefficient and two relaxation times. When the outer cylinder undergoes forced harmonic angular oscillations about its axis, and the inner cylinder is constrained by a torsion wire, the amplitude of uniform oscillation attained by the inner cylinder is calculated. The ratio of the angular amplitudes of the 2 cylinders is plotted as a function of the frequency. In steady flow between rotating cylinders, elastico-viscous liquids behave like purely viscous liquids whose viscosity is a function of the rate of shear. Information about the rheological equations of state of actual liquids can be deduced from steady rotational experiments. A.

532.517.4

9299. Investigation of turbulent flow in a two-dimensional channel. J. LAUFER. *Overseas Res. Rep.*, 246/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv., Wash., PB.*101359.

A detailed exploration of the field of mean and fluctuating quantities. The measurements were

repeated at 3 Reynolds numbers. Mean-speed and axial-fluctuation measurements were made well within the laminar sublayer. The semi-theoretical predictions concerning the extent of the laminar sublayer were confirmed. The distribution of the velocity fluctuations in the direction of mean flow shows that the influence of the viscosity extends farther from the wall than indicated by the mean velocity profile, the region of influence being approximately four times as wide. Fluctuations perpendicular to the flow in the lateral and vertical directions, and the correlation coefficient were also measured. The turbulent shearing stress was computed by 3 different methods. The results show satisfactory agreement for the 2 lower Reynolds numbers. In the case of the highest Reynolds number the total shearing stress obtained from the fluctuation measurements was approximately 20% lower than that computed from the mean-velocity and mean-pressure measurements. All dimensionless mean fluctuating qualities were found to decrease with increasing Reynolds number. Measurements of the scales and microscales of turbulence across the channel are presented and their variation with Reynolds number is discussed. The energy balance in the turbulent flow field was calculated from the measured quantities. From this calculation it is possible to give a descriptive picture of turbulent-energy diffusion in the centre portion of the channel cross-section. A.

532.517.4

9300. The passage of turbulence through wire gauzes. A. A. TOWNSEND. *Quart. J. Mech. Appl. Math.*, **4**, 308–20 (*Sept.*, 1951).

Measurements were made of the turbulent intensities existing after the passage of isotropic turbulence through fine-mesh wire gauzes, and the results were compared with the predictions of the theory of Taylor and Batchelor. In agreement with the theory the intensities of transverse components of the transmitted turbulence are considerably greater than that of the longitudinal component, but the degree of anisotropy is less than predicted. These, and other comparisons, lead to the conclusion that the theory represents sufficiently accurately the motion at the gauze, but turbulent energy transfer within the zone of influence of the gauze leads to appreciable redistribution of energy between the turbulent velocity components. A.

532.525

9301. The round laminar jet. H. B. SQUIRE. *Quart. J. Mech. Appl. Math.*, **4**, 321–9 (*Sept.*, 1951).

An exact solution of the equations of viscous fluid flow for axially-symmetric motion is derived. This corresponds to the round laminar jet, or, alternatively, to the flow produced by the application of a force at a point in a viscous fluid. Some examples of the calculated streamlines are given. The effect of a source of heat at the point of application of the force is also considered. A.

532.527

9302. Interaction between turbulons. E. INOUE. *J. Japan Soc. Appl. Mech.*, **4** (*No.* 22) 25–7 (1951) *In Japanese with English abstract.*

A field of turbulent flow is conceived as composed of many ranks of turbulons of scale Λ and velocity V. The consideration of interaction between turbulons leads to the conclusion that the resistance, (W), acting on the surface of a turbulon during its interaction time is given by $W = 6\pi AV(\Lambda/2)$ where A, the coeff. of turbulent viscosity, is assumed $= \rho V\Lambda$. Assuming the same rate of energy dissipation, ε, for all ranks of turbulons, the $-5/3$ law of the turbulon spectrum, and the $-4/3$ law of turbulent viscosity coeff. are deduced. Upper and lower limits of turbulon lengths within which the law of turbulent viscosity coeff. is applicable are given as $\Lambda_0 \simeq \varepsilon^{-1/4}\kappa_0^{3/4}$; $\Lambda_\infty \simeq \varepsilon^{1/4}\nu^{3/4}$. J. S. G. THOMAS

532.528 : 534.321.9

9303. On certain physical and chemical properties of ultrasonic cavitation. P. RENAUD. *J. Chim. Phys.*, **48**, 336–8 (1951) *In French.*

Ultrasonic vibrations of frequency 1 Mc/s were focused into a beam of intensity 100 watts/cm². Ten explosives with sensitivities ranging between that of mercury fulminate and ammonium nitrate were placed in the beam for 20 min; the explosives were used both dry and dispersed in water through which oxidizing micro-sparks were being passed. In no case was a detonative reaction initiated. The chemical inefficiency of ultrasonic energy is attributed to the great difference between the ultrasonic frequencies used and molecular resonance frequencies. Similar expts. on KI showed that whereas vibrations at a frequency of 1 Mc/s produced oxidation with the liberation of free iodine, vibrations at a frequency of 20 kc/s were ineffective. It is suggested that at the higher frequency "gas cavitation" occurs, accompanied by micro-sparks producing O_3, but at the lower frequency there is "vapour cavitation" which is mechanically erosive, but produces no sparks.

A. SCHOFIELD

532.542

9304. The effect of friction on surges in long pipe-lines. A. N. BINNIE. *Quart. J. Mech. Appl. Math.*, **4**, 330–43 (*Sept.*, 1951).

A pressure fluctuation occurs in a pipe-line when the velocity of the liquid in it is altered by means of a valve. A method of calculating these surges in a gravity pipe-line is described for the 2 cases when the exit velocity is reduced to zero (i) instantaneously, and (ii) at a uniform rate. A.

532.582.2

9305. Some aspects of Rayleigh's problem for a compressible fluid. L. HOWARTH. *Quart. J. Mech. Appl. Math.*, **4**, 157–69 (*June*, 1951).

Rayleigh's problem, in which a plane is started to move parallel to itself through viscous fluid, is considered for the case when the fluid is compressible. An approx. expression for the pressure-time variation at the plane is obtained and the initial motion is considered. It is shown that the initial pressure variations determined, as here, from the classical equations are so rapid as to require reconsideration in the light of molecular phenomena, though there is little doubt that the entire pressure changes are limited to an interval, short by ordinary standards, and governed essentially by the time of relaxation. A.

532.582.2

9306. On the impulsive motion of a flat plate in a viscous fluid. K. STEWARTSON. *Quart. J. Mech. Appl. Math.*, **4**, 182–98 (*June*, 1951).

The motion in the boundary layer is investigated for a semi-infinite plate started from rest with a velocity V. The velocity field is independent of x, the distance along the plate, if $Vt < x$, and at $Vt = x$ the flow has an essential singularity, depending on x and t as well. As $t \to \infty$ the influence of t dies out exponentially. Solutions are obtained using 2 approx. methods and they agree. The same problem is solved for a compressible fluid. A.

532.593

9307. Wind tides in small closed channels. G. H. KEULEGAN. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 358–81 (*May*, 1951).

In addition to the generation of waves, a wind produces a mass transport in a body of water resulting in the lowering of the level at the windward side and rise at the leeward side, which is called wind tide or set-up. Two effects of the wind are involved: the surface traction on the water, and the form resistance of the waves. This paper presents the theoretical background of the subject and experimental results. A.

CAPILLARITY 532.6

532.6

9308. Formulae for calculating the surface tension of metals. L. L. KUNIN. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 1) 93–6 (1951) *In Russian.*

Theoretical. Equations proposed by other authors (all Russian) for the surface tension of metals are critically discussed; the results calc. from these equations are in poor agreement with experiment. Modification of Samoĭlovich's equation $\sigma = 0{\cdot}30\rho_0^{7/6} - 0{\cdot}76\rho_0^{3/2}$ (ρ_0 = density of the electron gas) by introducing a factor for the true number of free electrons gives results in better agreement with practice. However, better agreement still can be obtained by using an empirical equation $\sigma = 444{\cdot}5\psi/R^2 - 110$ erg/cm^2, where ψ is the min. work function of the electron in volts, and R is the atomic radius in Å.

W. HUGHES

532.61

9309. Surface tension of liquid metals. R. A. WEALE; S. W. SMITH. Letters in *Nature, Lond.*, **168**, 343–4 (*Aug.* 25, 1951).

Weale shows that Auerbach's formula [Abstr. 2389 (1949)] relating surface tension with density and velocity of sound can be converted to one similar to Wen Po's [*Phil. Mag.*, **23**, 33 (1937)] relating s.t. with atomic weight and the Debye frequency. Smith also states that the reciprocal of s.t. is a function of the 2/3 power of the atomic volume. R. A. WEALE

532.612.4

9310. The surface tension of supercooled phenyl ether. C. DODD. *Proc. Phys. Soc., Lond. B*, **64**, 761–4 (*Sept.*, 1951).

Determinations of the surface tension of phenyl ether have been made, using Jaeger's method, for the liquid in both the ordinary and the supercooled state. No abnormal change with temperature, of the type already found for viscosity and dielectric constant, has been detected for surface tension as the liquid enters the supercooled region. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

9311. Experimental evidence for the existence of transverse thermal waves in liquids. C. S. VENKATESWARAN. Letter in *Curr. Sci.*, **20**, 177–8 (*July*, 1951).

On the basis of the hole theory Frenkel has discussed scattering due to the rotational vibration of anisotropic molecules in a liquid. It is now shown that the application of this theory to the results of previous experimental work by the author [Abstr. 133 (1943)] gives evidence for the existence of transverse thermal waves in liquids. T. C. TOYE

532.7 : 534.22

9312. Investigations on the velocity of sound and nature of the medium. I. The velocities of sound in organic liquids. W. SCHAAFS. *Z. Phys. Chem.*, **194** (*No.* 1–2) 28–38 (1944) *In German.*

Various methods of measurement are discussed, and data for many organic liquids given. Some temperature coefficients of the velocity of sound are also investigated, and adiabatic compressibilities are calculated. P. T. LANDSBERG

532.7 : 534.22

9313. Investigations on the velocity of sound and nature of the medium. II. The relationships between the velocity and molecular structure. Their applications to pure hydrocarbons. W. SCHAAFS. *Z. Phys. Chem.*, **194** (*No.* 1–2) 39–50 (1944) *In German.*

A roughly linear relation is found between the velocity of sound and a simple function of the molecular volume. P. T. LANDSBERG

532.7 : 534.22

9314. Investigations on the velocity of sound and nature of the medium. III. The relationships between velocity of sound and molecular structure for hydrocarbons with oxygen, nitrogen and halogen atoms. W. SCHAAFS. *Z. Phys. Chem.*, **194** (*No.* 1–2) 66–85 (1944) *In German.*

Continuation of previous work [see preceding abstracts]. Detailed comparison is made between calculated and measured sound velocities for 80 substances. P. T. LANDSBERG

532.7 : 534.22

9315. Investigations on the velocity of sound and nature of the medium. IV. Velocity of sound and dipole moment. W. SCHAAFS. *Z. Phys. Chem.*, **194** (*No.* 3) 170–8 (1944) *In German.*

The velocity of sound can be utilized for the calculation of dipole moments by introducing it into Debye's theory. P. T. LANDSBERG

532.7 : 534.321.9

9316. Ultrasonic studies in electrolytes. II. Effect of including the electrolyte in a circuit. B. KRISHNAMURTY. *J. Sci. Industr. Res.*, **10B**, 149–51 (*July*, 1951).

For Pt I, see Abstr. 116 (1951). The effect of asymmetric charge distribution, brought about by the movement of ions towards the electrodes, on the ultrasonic velocity and adiabatic compressibility of aqueous solutions of $NaNO_3$, KNO_3, $Sr(NO_3)_2$ and $Ba(NO_3)_2$ at different molar concentrations have been investigated. The influence of an ultrasonic beam on the electrical resistance of the solutions and the relationship between molar compressibility (ϕ) and electrolyte concentration (c) have also been studied. As a result of the asymmetric charge distribution in the solutions studied, the ultrasonic velocity increases and the adiabatic compressibility decreases. The increase in ultrasonic velocity is independent of the concentration. The electrical resistance of the solutions increases when an ultrasonic beam is present. The apparent molar compressibility follows Gucker's linear relationship $\phi = a + b\sqrt{(c)}$ where a and b are constants. A.

532.7 : 532.13 : 534.321.9

9317. A peculiarity in the behaviour of ultrasonics in liquids. F. PORRECA. *Nuovo Cim.*, **8**, 521–7 (*Aug.*, 1951) *In Italian.*

When liquids are subjected to stationary ultrasonic radiations, variations in temp. may arise in the body of the liquid. These are related to induced local differences in viscosity which affect the rates of cooling of the liquids. Data for H_2O, ethyl polyglycol, vaseline oil, and aq. solutions of gelatin, glucose and Dispergal-O are presented. J. GRANT

532.72 : 535.417

Use of interference fringes for the measurement of diffusion coefficients. *See Abstr.* 9397

532.72/.73

9318. On the dependence of the diffusivity of dissolved substances on mass and volume of the particles. N. RIEHL AND G. WIRTHS. *Z. Phys. Chem.*, **194** (*No.* 3) 97–128 (1944) *In German.*

The conclusion, drawn from the diffusion theory of Einstein and Smoluchowski, that molecules or ions in solution which are rather similar to each other except for their masses behave similarly in diffusion, is verified experimentally. It is also shown experimentally that ions of equal charge can have similar diffusion coefficients even if they differ from each other chemically and geometrically. It is held that these conclusions have a theoretical basis also in the case of the smaller molecules, provided the hydrodynamical considerations of Einstein and Smoluchowski are replaced by the notion of slow particles moving in a periodic field. P. T. LANDSBERG

532.72/.73

9319. On the determination of Soret coefficients with the aid of permeable membranes. K. F. ALEXANDER. *Z. Phys. Chem.*, **195** (*No.* 3) 175–85 (1950) *In German.*

Investigation by an improved experimental method shows that the coefficient depends in a systematic manner on the properties of the membrane (e.g. on the size of its pores). P. T. LANDSBERG

532.77

9320. On the theory of the infinitely diluted solution. R. HAASE AND A. MÜNSTER. *Z. Phys. Chem.*, **194** (*No.* 4–6) 253–77 (1950) *In German.*

A re-examination of the theory. The arguments from thermodynamics are sharply divided from those based on statistical mechanics. The results are shown to supplement each other. P. T. LANDSBERG

532.77

9321. Study of several physical properties of electrolytes over the temperature range of 25°C to −73°C. A. B. GARRETT AND S. A. WOODRUFF. *J. Phys. Coll. Chem.*, **55**, 477–90 (*April*, 1951).

The eutectic mixtures, freezing points, electrical conductivities, viscosities and densities of ten solvent-electrolyte systems that are liquid over the temperature range 25° to − 73°C have been investigated. Significant data are: (1) the rapid increase in viscosities at low temperatures; (2) the comparison of the electrical conductivities of the acid and salt systems (over the entire temperature range) with that of KCl at room temperature; and (3) the large decrease in electrical conductivities towards −73°C. The following systems appear the more promising for use at −73°C: (1) eutectic HCl, (2) 43·5% HBF_4 stabilized with 2·2% HBO_3, (3) CH_3NH_2, HCl in H_2O, and (5) CH_3NH_2, HCl and LiCl in H_2O. There are 8 diagrams and 9 references. H. H. HODGSON

532.77

9322. Application of the theory of conformal solutions to the system carbon dioxide–ethylene. D. COOK AND H. C. LONGUET-HIGGINS. *Proc. Roy. Soc. A*, **209**, 28–36 (*Oct.* 8, 1951).

The theory of "conformal solutions" [see Abstr. 2427 (1951)] is used to calculate the liquid-vapour phase diagram of the azeotropic system carbon dioxide–ethylene in the critical region. For the calculations it is sufficient to know the thermodynamic functions of the pure components and the value of one theoretical constant. The calculated results are given as isothermal pressure-mole fraction plots at temperatures from −30 to +10°C. The theoretical curves agree well with those determined experimentally by Haselden, Newitt and Shah, establishing the usefulness of the theory in this interesting region. A.

532.782

9323. Discontinuities in supercooled ionic melts. N. N. GREENWOOD AND R. L. MARTIN. Letter in *Nature, Lond.*, **168**, 344 (*Aug.* 25, 1951).

Discontinuities observed in the viscosity/temperature and ionic-mobility/temperature graphs of BF_3 co-ordination compounds on passing from the normal liquid to the supercooled state are discussed. F. LACHMAN

MECHANICS OF GASES 533

533.15

9324. A contribution to the classical diffusion theory. G. BIEGELMEIER. *S.B. Öst. Akad. Wiss., Abt. IIa*, **159** (*No.* 3–6) 161–72 (1950) *In German.*

At the time $t = 0$ the concentration c in the cube

$-l < x_i < +l$ ($i = 1, 2, 3$; x_i = Cartesian coordinates) is 0, and in the surrounding space is c_0. The diffusion constant inside and outside is D. Then

$$C(x_1, x_2, x_3, t) = c_0 \prod_1^3 \left\{ 1 - \tfrac{1}{2}\left[\psi\left(\frac{x_i + l}{2\sqrt{(Dt)}}\right) - \psi\left(\frac{X_i - l}{2\sqrt{(Dt)}}\right)\right]\right\}$$

where $$\psi(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-x^2} dx.$$

The same result applies to the one- and two-dimensional case, if $i = 1$ or $= 1, 2$ respectively.

H. LONDON

533.15

9325. Diffusion and flow of gases and vapours through micropores. III. Surface diffusion coefficients and activation energies. P. C. CARMAN AND F. A. RAAL. *Proc. Roy. Soc. A*, **209**, 38–58 (*Oct.* 8, 1951).

For Pt II, see Abstr. 8547 (1950). When less than a complete monolayer is present, surface-diffusion coefficients decrease rapidly with decreasing coverage. This is attributed to variation in heats of adsorption over the adsorbent surface. Diffusion is due to the most loosely bound molecules, and these tend to disappear first as coverage decreases. Only a limited range of coverage could be followed in a given system and, within this, activation energies showed no marked variation. This should follow if molecules which require high activation energies play relatively little part in surface diffusion. In no system so far studied have activation energies been small enough to support the existence of "freely mobile" or "gas-like" adsorbed layers. A gas-like state is not approached at low coverages, since molecules adsorbed under these conditions are practically immobile. Surface diffusion coefficients compared at constant temperature and constant coverage differ for various molecules according to differences in molecular size, shape and polar character. When the monolayer is complete and multilayers are formed, diffusion coefficients are little dependent on coverage, and, though perhaps higher than for diffusion in the liquid state, are of a similar order of magnitude. Capillary condensation, in at least the initial stages, produces a rapid rise in surface-diffusion coefficients. Measurements in this region have only limited reproducibility. The importance of pore structure on the shape of adsorption isotherms is stressed. Its effect on surface-diffusion coefficients is indicated, but has not been followed in detail. A.

533.15

9326. On diffusion by discontinuous movements, and on the telegraph equation. S. GOLDSTEIN. *Quart. J. Mech. Appl. Math.*, **4**, 129–56 (*June*, 1951).

At time $t = 0$ a large number of non-interacting particles start from an origin and move with uniform velocity v along a straight line for an interval of time τ. Initially, half move in each direction. Then, and at the end of each successive interval τ, each particle starts a new partial path and moves still with speed v; there is a chance p that it will continue in the same direction, and a chance $1 - p$ that the direction will be reversed. The difference equation is found for the fraction $\gamma(n, v)$ of the number of particles at a distance $y = v\nu\tau$ from the origin after a time $t = n\tau$; it is shown how $\gamma(n, v)$ may be computed; asymptotic formulae for large n are found. The limiting density distribution is found when $n \to \infty$, $\tau \to 0$, with $n\tau = t$, $v\nu\tau = y$, and in the limiting operation $c = 1 - \tau/A$, where $c = 2p - 1$, and A is constant, so that $c \to 1$, and v is kept constant. The limiting form is the telegraph equation. The solution of this equation is considered, and is given in terms of Lommel's function of 2 variables. A.

533.15 : 536.253

9327. Deposition images of gas flow caused by thermal diffusion. K. CLUSIUS AND H. MEYER. *Z. Naturforsch.*, **6a**, 401–2 (*July*, 1951) *In German.*

Convections produced by a hydrogen flame at pressures of 30–200 mm Hg are made visible by deposition of evaporated salt (4 photographs). Also 2 photographs demonstrating the deposition by thermal diffusion of dust on the wall and ceiling of a room near a hot pipe. H. LONDON

533.21

9328. A method of determining the compressibility of gases at high pressures. I. R. KRICHEVSKIĬ AND D. S. TSIKLIS. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1169–72 (1951) *In Russian.*

An apparatus is described for use up to 10 000 atmos. It consists essentially of a metallic piezometer enclosed in a high-pressure chamber, filled with oil, one end of the piezometer being connected via a mercury trap to a high-pressure intensifier which is supplied with a piston on which is fitted a stuffing box. The stuffing box is designed to ensure hermetical sealing up to 10 000 atmos. Gas is led into the piezometer via another tube. The compressibility of the gas can be calculated from the vol. of gas used, the amount of mercury forced into the piezometer by the oil, and other easily determinable factors. The use of a stuffing box eliminates the corrections which were necessary for changes in the diameter of the intensifier cylinder on increasing the pressure in the type of apparatus previously used. The apparatus described was checked by means of an apparatus used for investigating phase equilibria [*J. Phys. Chem. USSR*, **17**, 115 (1943)]. Results obtained for N_2 at 50° were in good agreement with those obtained by Benedict (1937). W. HUGHES

533.21

9329. Compressibility of nitrogen at pressures up to 10 000 atmospheres. D. S. TSIKLIS. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 289–90 (1951) *In Russian.*

Using the method described (preceding Abstr.) the compressibility of N_2 was determined for the range 6 000 to 10 000 atmos. at 50, 100 and 150°c. The results were in good agreement with those calc. from Tait's equation $(v - v_0)\, v_0 = C \ln(B + p)/(B + p_0)$ taking v_0 as the vol. at 3 000 atmos. B depended only on temp. while C was independent of both temp. and pressure. C was found to be 0·3678, while the values of B for 50, 100 and 150° were −1 421, − 1 587 and −1 716 respectively. The results indicated that Bridgeman's values (1924) were high. The results are tabulated. W. HUGHES

533.5

9330. Device for automatic pressure control in a high-vacuum plant. M. CHIOZZOTTO. *R.C. Ist. Super. Sanità*, **14** (*No.* 8) 553–62 (1951) *In Italian.*

Regulates the rotary pump which produces the preliminary vacuum required by the diffusion pump in a high-vacuum plant. It guarantees automatic closing of the plant in case of a failure in the power supply to the rotary pumps. A.

533.5 : 537.534.74

9331. Leak detection with a mass spectrometer using hydrogen gas. M. E. REINDERS, J. SCHUTTEN AND J. KISTEMAKER. *Appl. Sci. Res.*, B2 (*No.* 1) 66–70 (1951).

The minimum detectable leak rate into the ion source (pumping speed 1 litre/sec) was found to be $0{\cdot}28$ mm^3/h (N.T.P.) for H_2^+, compared with 1 mm^3/day for He. 1 part of hydrogen was detectable in 10^4 parts of air, and 1 of helium in $5{\cdot}10^4$ of air. A Philips ion gauge just detected 50 mm^3/hr using ether vapour, so that the spectrometer may be used with advantage on hydrogen when helium is not available. Figures are given for other probe gases. [See also Abstr. 9540 (1951)]. T. G. PICKAVANCE

533.6.01 : 534.222.2

9332. On the theory of the forked compression shock. W. KOFINK. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 200–12 (1951) *In German.*

The problem for a gas of constant ratio of specific heats, γ, is shown to lead to an equation of the 6th degree for the determination of the primary and forward secondary shocks. The coefficients of this equation are derived. They depend on three known variables given by γ, the ratio of the inflow to the critical speed and the direction of the primary shock. Particular cases are considered which reduce the equation to equations of the 1 to 4th degrees the solutions of which can be used as suitable starting points for the numerical solution of the general case.

S. WEINTROUB

533.6.011.4

9333. On the calculation of the laminar boundary layer for supersonic velocity. H. SCHLICHTING. *Abh. Braunschw. Wiss. Gesell.*, **3**, 239–64 (1951) *In German.*

Recently L. Howarth has given a method of calculating the boundary layer for the velocity distribution and temperature near an insulated wall for compressible laminar flow, the Prandtl number being 1. It is shown here that approximate solutions of this problem can be obtained in a very simple way by applying the momentum method in the version given by H. Holstein and T. Bohlen for incompressible flow. A.

533.6.011.5 : 534.222.2

9334. Determination of the shock wave ahead of an obstacle of revolution when the velocity at the point of the obstacle is subsonic. H. CABANNES. *C.R. Acad. Sci., Paris*, **233**, 354–6 (*July* 30, 1951) *In French.*

Theoretical. In a previous paper [Abstr. 4169 (1951)] the paradoxical result was obtained that when the Mach number $M <$ a critical value M_1 the curvature of the attached shock is opposite to that of the obstacle. In the present paper the paradox is removed by the introduction of non-integral exponents into the power series. It is found that for $M < M_1$ the term $(r/R)^m$, where $0 < m < 1$, predominates over the 1st order term; when this non-integral term is taken into account the ratio of the curvatures of the attached shock and the obstacle is positive for all possible values of M, in accordance with experimental observation. A. SCHOFIELD

533.6.011.6

9335. Experiments on aerodynamic cooling. L. F. RYAN. *Diss. E.T.H., Zürich, No.* 1981, 52 *pp.* (1951). Also in *Mitt. Inst. Aerodyn. E.T.H. Zürich, No.* 18. *In English, with German abstract.*

The surface temperatures of bodies of various shapes—a circular cylinder, a hemi-circular cylinder terminated by 5 different sections facing the stream, a circular cylinder fitted with end plates, a body resembling a rifle bullet in section, a body of elliptic and one of aerofoil section—immersed in a stream of dry air flowing in a wind tunnel at subsonic velocities are compared with the temperature of the stagnant air and the results correlated with the phenomena of flow as revealed by pressure measurements and Schlieren photographs. Flows ranging from Mach number $0{\cdot}35$ to $0{\cdot}75$ were used and the Reynolds number was usually 120 000. The surface temperatures measured in the case of streamline motion and laminar boundary layer, agree well with theoretical deductions, deduced in the case of a smooth lamina, for the temperature outside the boundary layer by means of the theory developed by Hautzsche and Wendt. In the case of flow past the circular cylinders, under certain wind-tunnel operating conditions, whistling sounds were heard, probably due to resonance. With increase of Mach number, the sound built up to max. intensity and then cut off suddenly. Accompanying this sound phenomenon, the temperature at the rear surface of the body decreased, and the pressure at the same point decreased to local minima as the sound attained max. intensity, then rose abruptly, as the sound cut out. These sound effects were observed to lie within Mach number intervals of about $0{\cdot}05$–$0{\cdot}15$. From Schlieren photographs it was concluded that sound was at a max. when the vortex street behind the body was most pronounced. The most marked temperature minimum and most intense whistling were found at very high Mach number. In the region of detachment of the stream from the obstacle, very low temperatures were measured. This phenomenon previously observed by Eckert and Weise for the case of a circular cylinder, is now confirmed for obstacles of various sections. J. S. G. THOMAS

533.6.08

9336. A note on thermocouple anemometer. S. KAWATA. *Mem. Fac. Engng Kyoto Univ.*, **13**, 49–53 (*Jan.*, 1951).

The question of automatic compensation for the temp. of the air is discussed. It is shown that by suitable selection of the components of a hot-wire thermocouple anemometer it is possible in theory to obtain $(i^2 - i_0^2) = k_2 v^{\frac{1}{2}}$ for the relationship between the current i in the wire to maintain a constant e.m.f.

and the velocity v of the air, where k_2 is a constant independent of the wire or air temperature and i_0 is the value of i in still air. Results obtained with a test instrument consisting of chromel/alumel wires attached to constantan are briefly discussed and the deviation from the theoretical relation is attributed to the effect of free convection currents. The advantages of the constant e.m.f. and constant current methods are briefly compared. S. WEINTROUB

MOLECULAR THEORY OF GASES 533.7

533.73

9337. On Boltzmann's equation in the kinetic theory of gases. E. WILD. *Proc. Camb. Phil. Soc.*, **47** (*Pt* 3) 602–9 (1951).

By first integrating Boltzmann's equation for the molecular velocity distribution function it is shown that if the mean collision frequency is known as a function of space, time and the velocity of a colliding molecule the equation for the initial value problem in unbounded space can be solved if a solution exists at all. The method is applied to a gas for which the mean collision frequency is constant. T. C. TOYE

533.75

9338. On the second and third virial coefficient of methyl fluoride. R. J. LUNBECK AND C. A. TEN SELDAM. *Physica*, **17**, 788–92 (*Aug.*, 1951).

Because of the polar character of methyl fluoride its virial coefficients cannot be described by a formula of the Lennard–Jones type for the molecular interaction. On extending this formula with a term, representing the dipole interaction, a good agreement was found between experimental and calculated values of the second and third virial coefficients. Only two constants had to be determined, the third constant occurring in the formula for the intermolecular field was taken from dielectric constant measurements. A.

VIBRATIONS . ACOUSTICS 534

534.1

9339. A theorem of use in wave theory. E. PINNEY. *J. Math. Phys.*, **30**, 1–10 (*April*, 1951).

The theorem relates to the evaluation of a double integral (one being a contour integral). It is of value in numerical calculations in the theory of elastic waves, and is applicable to other problems involving solutions of the wave equation. It can be applied to regions in which one or more wave velocities appear, and it may have applications in the theory of crystal optics. L. S. GODDARD

534.13

9340. Dynamics of the vibration of a bar excited by the longitudinal impact of an elastic load. M. GHOSH AND S. K. GHOSH. *Indian J. Phys.*, **25**, 153–62 (*April*, 1951).

The main idea upon which the dynamics is built up is that the bar behaves like a loaded bar so long as the load is in contact with it, and the elastic load is supposed to behave like a hard load backed by a weightless spring. Two distinct cases have been worked out, using the operational method, from the general solution, namely, (i) when the load strikes the free end, and (ii) when the load strikes the fixed end of the bar. The method gives the solution for any epoch very easily. A.

534.131

9341. Elastic vibrations of almost cubic parallelepipeds. H. EKSTEIN AND T. SCHIFFMAN. Letter in *J. Appl. Phys.*, **22**, 1215 (*Sept.*, 1951).

The longitudinal vibrations are deduced from a cube by a perturbation method and their degeneracy briefly considered. J. E. CAFFYN

534.21

9342. Pressure waves in liquids. C. F. SQUIRE. *Texas J. Sci.*, **3**, 173–5 (*June* 30, 1951).

A short review is given showing how measurements of the velocity and attenuation of sound or compression waves in the megacycle range has given information on the properties of liquids.

G. F. HODSMAN

534.21, 538.566

9343. The correlation function in the analysis of directive wave propagation. H. NODTVEDT. *Phil. Mag.*, **42**, 1022–31 (*Sept.*, 1951).

It is shown that the auto-correlation function might be applied when investigating the directive properties of waves which cover a wide frequency spectrum. Examples are given which clearly show that the subsidiary maxima in the calculated polar diagrams are reduced when widening the frequency band of the received signals. These subsidiary maxima are, further, smaller than those obtained when using ordinary phase comparison methods under the same conditions. Some possible implications in the field of audio-acoustics are mentioned, dealing with the sense of directivity of the human ears. A.

534.213

9344. The interaction of screw dislocations and sound waves. F. R. N. NABARRO. *Proc. Roy. Soc. A*, **209**, 278–90 (*Oct.* 23, 1951).

Peierls's model of a dislocation is adapted to dynamical problems by taking account of the inertia of the matter which in a continuum would lie between the two sheets of atoms defining the glide plane. The scattering of long shear waves by a screw dislocation is examined. The scattering cross-section is nearly proportional to the wavelength. The force acting on the dislocation in the direction of propagation of the wave depends on a specific interaction between a moving dislocation and a varying displacement field. This interaction is derived formally from an electromagnetic analogy, and its meaning is discussed. By its use, the momentum transfer cross-section is calculated, and shown to equal the scattering cross-section. The results are applied to analyse Leibfried's estimate [Abstr. 6773 (1950)] of the resistance to the motion of a dislocation caused by its interaction with lattice vibrations. The estimate depends on a con-

fusion of two effects. It is shown for each effect that the contribution of long waves to the resistance is smaller than that calculated by Leibfried, but no quantitative estimate is given for the contribution of waves near the top of the Debye spectrum. It is concluded that Leibfried's result is correct in form and order of magnitude, but numerically too high. A.

534.22 : 532.7

Investigations on the velocity of sound and nature of the medium. *See Abstr.* 9312–15

534.222.2

9345. On a problem of interaction of plane waves of finite amplitude involving retardation of shock-formation by an explosive wave. P. M. STOCKER. *Quart. J. Mech. Appl. Math.*, **4**, 170–81 (*June*, 1951).

The interaction, in an inviscid perfect gas with constant specific heats in the ratio 5/3, of a receding simple compression wave and an advancing, centred, simple expansion wave is calculated by the method of characteristic co-ordinates. The time is found by which the interaction delays the formation of a limit line. Shock formation can be delayed considerably but not indefinitely. A.

534.222.2

9346. A note on the pseudo-stationary flow behind a strong shock diffracted or reflected at a corner. D. M. JONES, P. M. E. MARTIN AND C. K. THORNHILL. *Proc. Roy. Soc. A.*, **209**, 238–48 (*Oct.* 23, 1951).

534.222.2 : 537.56 : 539.17

9347. Luminosity at the encounter of shock waves produced by hollowed charges. J. THIBAUD AND D. PERRIER. *Nuovo Cim.*, **8**, 705–12 (*Sept.*, 1951) *In French.*

The encounter of shock waves in argon and air is studied, with a view to their ultimate utilization for initiating thermo-nuclear reactions. The shock waves are generated by one or two hollowed charges having a convergent effect: the luminosity produced by the encounter of the waves is observed for pressures lower than normal (a few mm of Hg in A) and in the presence of an electrostatic field which serves to accelerate the ions produced at the point of encounter of the waves. A.

534.23 : 534.321.9

9348. A simple method of measuring absorption of supersonic waves in strongly absorbing solid bodies. I. G. MIKHAÏLOV AND V. A. SOLOVEV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 245–8 (1951) *In Russian.*

The apparatus consists essentially of a supersonic generator (quartz oscillator) providing a concentrated beam in a water bath, a prism of the investigated material placed in its path and a receiver (either mechanical or piezo-electrical) registering the intensity of the refracted beam. A calibrated displacement of the prism allows a variation of path length without affecting refraction which takes place in one plane of the prism only. A formula for the absorption coefficient is derived, accuracy and error sources of the equipment are discussed and results of measurements on 4 materials (polystyrol, bitumen, polymethyl-metacrylate and rosin) are tabulated and plotted against frequency. A. LANDMAN

534.23

9349. On sound absorption by vibrating plates. H. ORMESTAD. *K. Norske Vidensk. Selsk. Forhandl.*, **23**, *Paper* 2, 3–6 (1950).

Formulae are derived for the impedance of a system comprising a vibrating plate fixed at the edges and closing an airspace. It is shown how the absorption and selectivity of such a system used for sound absorption in rooms can be influenced by matching the friction of the system to the specific acoustic resistance of the air and the use of rock-wool or cotton-wool in the airspace is suggested. G. F. HODSMAN

534.23

9350. Experiments with sound absorption by damped vibrating plates. H. ORMESTAD. *K. Norske Vidensk. Selsk. Forhandl.*, **23**, *Paper* 3, 7–10 (1951).

It has been suggested (see preceding Abstr.) that rock-wool and cotton-wool in the air space enclosed behind a vibrating plate acting as a sound absorber, could be used to match the friction of the vibrating system to the acoustic resistance of the air. Results of experiments with various thicknesses and amounts of cotton-wool are given, the different resonances, values of friction and absorption coefficients being quoted. G. F. HODSMAN

534.231

9351. Discussion of papers by Pachner and by Strenzel on radiation from a circular emitter. R. L. PRITCHARD. Letter in *J. Acoust. Soc. Amer.*, **23**, 591 (*Sept.*, 1951). See Abstr. 4779 (1950), 5195–6 (1951).

534.231 : 538.566 : 778.3

9352. A photographic method for displaying sound wave and microwave space patterns. W. E. KOCK AND F. K. HARVEY. *Bell Syst. Tech. J.*, **30**, 564–87 (*July*, 1951).

A probe pick-up scans the sound or microwave field and the amplified probe output controls the brilliance of a small lamp affixed to the probe. A camera set at time exposure records the light intensity variations of the lamp as it moves across the scanned field, forming a pattern on the film of the amplitude distribution. Phase fronts can be delineated by adding a constant amplitude signal to the probe output. Photographs are included which show: sound and microwave patterns of lenses, diffraction at a straight edge and disk, refraction by a prism, diffusion of sound by a divergent lens and radiation from loud speakers. Also, by transposition of source and receiver, directional patterns of transducers acting as microphones are obtained which (by reciprocity) appear identical with their radiation patterns. This provides a means for examining the directional characteristics of non-reversible transducers such as a carbon microphone. A calibration method is described which allows the relative value of the field intensities to be determined. A.

534.232 : 537.228.2

9353. Mechanical breakdown of quartz transducers at resonance. T. F. HUETER. Letter in *J. Acoust. Soc. Amer.*, **23**, 590 (*Sept.*, 1951).

An error is pointed out in previous work [Abstr. 1771 (1947)] and recent data for breaking stress of quartz and ADP tabulated. The limit for mechanical

breakdown is shown to be much greater than that for electrical breakdown in the fluid surrounding the crystal.

534.232 : 538.566

Kirchhoff's formula, its vector analogue, other field equivalence theorems. *See Abstr.* 9616

534.26 : 538.566 : 535.42

Diffraction and reflection of pulses by wedges and corners. *See Abstr.* 9400

OPTICS . RADIATION . SPECTRA 535

535.214.4

9354. On the use of alternating light in thermal radiation receivers. G. BAUER. *Abh. Braunschw. Wiss. Gesell.*, **3**, 1–9 (1951) *In German.*

Shows that the radiation sensitivity of thermal receivers becomes about four times smaller with alternating light instead of constant light. But the smaller disturbances of the alternating light method and the possibility of using electronic amplifiers yield practically the same limit of accuracy as the method of constant light. This limit is still smaller for the alternating light method in comparison with constant light, where the thermal motion of the electrons dominates. Assuming plausible conditions for the band-width of the alternating light and the time of measure for constant light the accuracy of the alternating light bolometer is further diminished by the factor 5. It is therefore concluded that the smallest detectable amount of radiation in relation to the disturbances is about 20 times smaller in the case of modulated light. A.

535.214.6

9355. On photophoresis in very high vacuum. F. EHRENHAFT AND E. REEGER. *C. R. Acad. Sci., Paris*, **233**, 385–7 (*July* 30, 1951) *In French.*

Vacua $\sim 10^{-6}$ Torr were produced by orthodox pumping methods, and maintained by metallic Ba as getter. The trajectories of graphite, Fe and Co particles in horizontal solar light showed that a force acted, sometimes in the direction of the light, sometimes against it. N. CORCORAN.

535.231.3

9356. Pressure of radiation in non-linear electrodynamics. B. KWAL. Letter in *J. Phys. Radium*, **12**, 762 (*July–Aug.–Sept.*, 1951) *In French.*

The electrodynamics of Born and Infeld lead to the conclusion that a temperature limit of the order of $1{\cdot}5\times10^{9}$ degrees exists, at which the entropy of radiation would become infinite. This results from the fact that the relation $p = u/3$, characteristic of Maxwell's electrodynamics, does not hold, and in fact there is no simple relation between p and u. It is here pointed out that an approximate linear relation can be used to study the modifications of the Stefan–Boltzmann law for values of the energy density $\ll b^2$.

535.31

9357. Focusing in an absorbing medium. G. D. MALYUZHINETS. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 229–30 (1951) *In Russian.*

If the focus is defined as the point at which the modulus of the function describing the wave field has a maximum, the following problem may be set. For which complex values of the wave number does focusing become impossible? This is answered by the following theorem. Let the function w satisfy in a domain G the following equation $\Delta w + \lambda w = 0$. It is necessary and sufficient for preventing the function w from having a maximum in G that the real part of λ be negative, in other words, that the imaginary part of the wave number λ have a greater modulus than the real part. This theorem is proved quite generally, and the method of the proof and its results may be used for proving the uniqueness theorem of the solution of the problem of forced harmonic oscillations in an arbitrary domain.

B. F. KRAUS

535.317.1

9358. A remark on the theory of optical images. J. HOLTSMARK. *K. Norske Vidensk. Selsk Forhandl.*, **23**, *Paper* 27, 113–15 (1951).

The perfection of an optical image depends upon the number of orders in the diffraction system which are effective in the image formation, this being restricted by the wavelength of the light and the numerical aperture. The calculation of the image can be carried out in two stages, (*a*) the calculation of the diffraction pattern at the lens system and (*b*) the calculation of the image by an integrating process in the plane of the image. R. W. FISH

535.317.1

9359. On the calculation of optical images. J. HOLTSMARK. *K. Norske Vidensk. Selsk. Forhandl.*, **23**, *Paper* 28, 116–21 (1951).

The diffraction system at the lens is calculated, and by an integration, carried out physically by the lens itself, the wave function in the image plane is determined. This takes the form of an integral equation which transforms the object into the image. Consideration of this equation reveals the usual relationship between resolving power, wavelength and relative aperture. R. W. FISH

535.317.1

9360. Image formation outside the focal plane. E. MENZEL. *Optik*, **8** (*No.* 7) 295–301 (1951) *In German.*

The light distribution in image planes near the position of focus is found in terms of Fresnel diffraction. An approximation has a practical value in interpreting the variation of a microscope image with focusing. The analysis of the light distribution in planes near focus is shown to yield information regarding the phase and absorption properties of microscope objects. R. W. FISH

535.323, 535.341

9361. Optical properties of selenium. J. J. DOWD. *Proc. Phys. Soc., Lond. B*, **64**, 783–9 (*Sept.*, 1951).

Measurements have been made of the refractive index of amorphous Se in the red and near infra-red spectral region. The absorption coefficient of amorphous Se has been measured in the ultra-violet, visible and near infra-red spectral regions. The transmission coefficients of several single crystals of Se have been

measured and an estimate made of the absorption coefficient in the wavelength range 0·68 to 2·0 μ. The results show that the absorption edge of the crystalline material occurs at about the same wavelength as that for the amorphous form. A discrepancy between the value of the near infra-red refractive index and the dielectric constant of amorphous Se indicates a further absorption band in the infra-red. A.

535.323 : 535.33.07

9362. Refractivity of lithium fluoride with application to the calibration of infrared spectrometers. L. W. TILTON AND E. K. PLYLER. *J. Res. Nat. Bur. Stand., Wash.*, **47**, 25–30 (*July*, 1951).

The refractivity was measured from 0·4 to 5·9 μ and expressed for 23·6°C by a four-constant dispersion formula by which an interpolation table was prepared for included wavelengths. The temperature coefficient was determined as $-1{\cdot}63\times10^{-5}$ (constant within $\pm$ 0·05) for the visible region and a table of indices made for 20° to 60°C at equal intervals of λ from 0·4 to 0·7 μ. Most of the observed indices agree with the tabulated values within $\pm\ 3\times10^{-6}$ for the visible region and $\pm\ 3\times10^{-5}$ in the infrared. In calibrating an infrared spectrometer simple empirical relationships between drum reading, D, and wavelength are not entirely reliable. Three steps are recommended: (1) the expression of D in terms of E, the emergent angle of energy from the prism; (2) expression of E in terms of refractive index; and (3) the obtaining of the indices or their expression as a function of λ. The first step requires at least two constants, one for angular equivalent of the screw and another for the particular Littrow-mirror orientation for $D = 0$. The second requires knowledge of the refracting angle of the prism and its orientation with respect to the incident energy. The adequate expression of index as a function of wavelength usually requires four constants. A.

535.33.03 : 531.711

9363. Comparisons of wave-length standards emitted by mercury-198 lamps. H. BARRELL. *Proc. Roy. Soc. A*, **209**, 132–41 (*Oct.* 8, 1951).

The reproducibility of high-quality wavelength standards emitted from water-cooled mercury-198 discharge lamps of the electrodeless and cold-cathode (Geissler) types has been investigated by means of a Fabry–Perot interferometer. These lamps contain a small quantity of the isotope Hg^{198} with argon, as carrier gas, at a nominal pressure of 3 or 5 mm in electrodeless and 10 mm in cold-cathode lamps; electrodeless lamps containing only the isotope and its vapour are also available. Employing for excitation a 100 Mc/s oscillator with electrodeless lamps and a transformer delivering 750 V at 25 mA and 50 c/s with cold-cathode lamps, the wavelengths of six Hg^{198} lines between 4046 and 5 791 Å, emitted from a sample of each kind of argon-filled lamp, have been measured in terms of the Cd red line at retardations of 5 to 25 cm. These measurements, supplemented by intercomparisons of argon-filled and argon-free electrodeless lamps at a retardation of 20 cm, reveal that Hg^{198} lines are probably subject to an asymmetrical pressure-broadening effect, producing a red shift of about 0·0001 Å ($-$ 0·0004 cm^{-1}) per mm of argon. Wavelength reproducibility among different samples of the same kind of lamp with the same filling is of the order of $\pm$ 0·00005 Å, or $\pm$ 1 part in 10^8, for electrodeless lamps and $\pm$ 0·0001 Å for cold-cathode lamps. A.

535.33.07 : 535.24

9364. Light flux received by a spectrograph from a spatially extended refracting source. L. A. WOODWARD AND J. H. B. GEORGE. *Proc. Phys. Soc., Lond. B*, **64**, 780–2 (*Sept.*, 1951).

The geometrical-optical treatment of Nielsen, which referred to a spatially extended source of refractive index unity, is extended to sources of any refractive index. Provided that the direction of emergence of the light from the source is nearly normal, it is shown that a change of refractive index from 1 to n modifies the light flux by the factor $1/n^2$. This result is independent of whether or not a condensing lens is used between source and spectrograph. Its relevance in connection with observed intensities in Raman spectra is discussed. A.

535.33.07–15

9365. The effect of change of angle of incidence on the calibration of infra-red prism spectrometers. W. GUY AND J. H. TOWLER. Letter in *J. Sci. Instrum.*, **28**, 321–2 (*Oct.*, 1951).

The permissible tolerance for replacement of the prism, if calibration is not to be significantly affected, is calculated, and a formula is provided.

535.331

9366. Observations on the spectra of arcs in air and hydrogen between aluminium electrodes. R. RICARD AND A. DUFOUR. *C.R. Acad. Sci., Paris*, **233**, 370–2 (*July* 30, 1951) *In French.*

A note describing certain differences between the Al spectra in air and H_2 and suggesting that certain impurities might be assessed more easily, by spectrographic analysis, in the latter case. J. D. CRAGGS

535.331 : 538.615

9367. Measurements of Zeeman effect in the Mn I spectrum. M. A. CATALÁN AND O. GARCÍA RIQUELME. *An. Real. Soc. Esp. Fis y Quim.*, **47A**, 173–80 (*July–Aug.*, 1951) *In Spanish.*

Measurements in the arc spectrum have been made in the region 2 460–4 825 Å. From these measurements g-values have been deduced for many energy levels. The resulting values confirm the preliminary analysis of Mn I. A.

535.338

9368. Multiplets and terms in technetium spectra. W. F. MEGGERS. *J. Res. Nat. Bur. Stand., Wash.*, **47**, 7–14 (*July*, 1951).

Multiplets and terms of the quartet, sextet and octet systems are reported for the first spectrum of Tc. The combinations of 20 terms composed of 63 atomic energy levels account for 200 Tc I lines and 66% of the total observed intensity summed for 1 300 lines. The ground state of neutral Tc atoms is represented by $4d^5 5s^2\ {}^6S_{2\frac{1}{2}}$, and the first metastable state by $4d^6\ 5s\ {}^6D_{4\frac{1}{2}}$, only 2 573 cm^{-1} higher. A Rydberg series of ^8S terms yields absolute term values from

which a Ritz-corrected limit of 60 070 cm^{-1}, or ionization potential of 7·45 eV, is derived. In the second spectrum of Tc the principal S and P terms of the quintet and septet systems are identified and fixed relative to each other. Evidence is presented that $4d^6\ ^5D$ represents the normal state of Tc^+ ions, but to confirm this further observations of the Tc II spectrum are necessary. A.

535.338.3

9369. Multiplet intensities for the lines $^1D - {}^3P$ of O III and Ne V. S. OBI. *Publ. Astron. Soc. Japan*, **2** (*No.* 4) 150–5 (1951).

The relative strengths of the transitions $1s^22s^22p^2\ ^1D_2 - {}^3P_2$ and $1s^22s^22p^2\ ^1D_2 - {}^3P_1$ in O III and Ne V are computed including mutual magnetic interactions. The radial integrals which determine the influence of various couplings on the transition probability were calculated with wave functions of the analytic type determined by the present author. The theoretical values of the ratios of the intensities in O III and Ne V for $^1D_2 - {}^3P_2$ and $^1D_2 - {}^3P_1$ are 2·90 and 2·79 respectively. As is known from simple consideration, the influence of mutual magnetic interactions on the transition probability is very small, but their effects on multiplet splittings are considerable. A.

535.34 : 539.11

9370. Light absorption as a result of an interaction of two states of valency of the same element. W. A. WEYL. *J. Phys. Coll. Chem.*, **55**, 507–12 (*April*, 1951).

A discussion and an interpretation of the published literature on phenomena arising from the interaction of ferrous and ferric ions in glasses and crystals.

A. J. KENNEDY

535.34 : 539.11

9371. The color change of ferrous hydroxide upon oxidation. R. R. SHIVELY, JR AND W. A. WEYL. *J. Phys. Coll. Chem.*, **55**, 512–15 (*April*, 1951).

A dilution method for the study of electron-transfer processes is explained (see also preceding Abstr.). Co-precipitates of $Fe(OH)_2$ and other colourless hydroxides were oxidized by exposure to air and colour changes observed over a range of values for the $Fe(OH)_2$ content. The minimum Fe concentration necessary for the ferrous-ferric ion interaction was deduced from these observations, and the process interpretated in terms of an electron exchange, the distance over which this is possible depending on the deformation of the hydroxide ions. A. J. KENNEDY

535.343–15

9372. The absorption frequencies of CH and their perturbations. I. Experimental study. P. BARCHEWITZ AND R. CHABBAL. *J. Phys. Radium*, **12**, 637–41 (*June*, 1951) *In French.*

The absorption spectra in the near infra-red of several organic halides, nitrocompounds, and hydrocarbons have been measured. The presence of highly polar groups and of multiple bonds in the molecule displaces the fundamental frequency of the C–H bond. W. R. ANGUS

535.343–15

9373. Differentiation between acenaphthene and naphthalene by their absorption spectra in the infra-red from 3 to 15 μ. J. GARACH AND P. BARCHEWITZ. *C.R. Acad. Sci., Paris*, **233**, 31–2 (*July* 2, 1951) *In French.*

The positions and relative intensities of infra-red absorption bands of acenaphthene and naphthalene between 3 and 15 μ are tabulated. Bands at 3·5 and 13·4 μ for acenaphthene enable differentiation to be made. W. R. ANGUS

535.343–15 : 535.375.5

9374. Infra-red absorption and Raman spectra of hydrofluoric acid. E. SAFARY, B. VODAR AND R. COULON. *C.R. Acad. Sci., Paris*, **232**, 2415–18 (*June* 25, 1951) *In French.*

The infra-red absorption spectra of HF at 20°C for the gaseous state between 4 200 and 3 100 cm^{-1} and for the gaseous and liquid states between 10 600 and 2 600 cm^{-1} are given. Association to form dimers F-H-F-H and higher polymers of disymmetric structure is believed to occur. Fluorescence renders study of the Raman spectrum difficult. W. R. ANGUS

535.343–15 : 535.375.5

9375. The vibration spectrum of [zinc] blende. J.-P. MATHIEU and L. COUTURE-MATHIEU. *C.R. Acad. Sci., Paris*, **233**, 32–5 (*July* 2, 1951) *In French.*

Observed infra-red and Raman frequencies of zinc blende are given. Good agreement is obtained between the observed frequency of the principal vibration and the theoretical value calculated by Born [*Atomtheorie des Festen Zustandes, Leipzig* (1923) *p.* 629]. W. R. ANGUS

535.343–32

9376. Ultra-violet absorption spectra of gallium and indium monofluorides. D. WELTI AND R. F. BARROW. Letter in *Nature, Lond.*, **168**, 161 (*July* 28, 1951).

Results of vibrational analyses of the three band systems observed in the ultra-violet absorption spectra of gallium and indium monofluorides at 1 000°C and 1 400°C respectively are given and constants have been derived. W. R. ANGUS

535.343.2–15

9377. Infra-red absorption spectra of [about 20] metallic carbonates in the powdered state. J. LOUISFERT. *C.R. Acad. Sci., Paris*, **233**, 381–3 (*July* 30, 1951) *In French.*

Frequencies and qualitative intensities are given for the regions 1 050–1 096, 820–880 and 675–745 cm^{-1}. Results are considered in relation to the different symmetries; in some cases there are more frequencies than expected and these are being investigated with polarized radiation.

G. F. LOTHIAN

535.343.3/.4–15

9378. Infrared spectrum of bromochlorofluoromethane. E. K. PLYLER AND M. A. LAMB. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 382–4 (*May*, 1951).

The positions of the absorption bands have been determined for the liquid and vapour states and all fundamental bands except one at 220 cm^{-1} have been observed. The position of this band has been predicted from other bands that are classified as combinations of two fundamental bands, one of which was

the 220 cm^{-1} band. Many of the bands of low or medium intensity have been classified as combinations or overtones of the nine fundamentals. A.

535.343.3–31

9379. The ultra-violet absorption spectra of the aromatic amino acids in proteins and related compounds. G. H. Beaven, E. R. Holiday and E. M. Jope. *Disc. Faraday Soc., No.* 9, 406–17 (1950).

Examination of fine structure of absorption bands reveals small shifts of up to 30 Å (to longer wavelengths) in spectra of aromatic amino acids, caused by linkage into peptide chains and incorporation into protein. Tripeptides of aromatic amino acids are thus suggested as better reference compounds than the simple acids in spectral analysis. Change of state is also shown to produce shift of spectra.

C. TURNER

535.343.3–31

9380. Electronic bands of paradibromobenzene. K. Sreeramamurty. Letter in *Curr. Sci.*, **20**, 176 (*July*, 1951).

The near u.v. band is $A_{1g} \rightarrow B_{3u}$ with the dipole moment $\perp$ to the *p*-carbons. Frequencies of the upper state are 470, 677, 1 014, 1 449 cm^{-1}.

J. JACOBS

535.343.4

9381. Absorption spectrum of phenetole. K. Sreeramamurty. *Indian J. Phys.*, **25**, 123–30 (*March*, 1951).

About 90 bands were measured in the near ultra-violet absorption spectrum of phenetole vapour in the region λ 2785 to λ 2385. The bands were broader than those of its lower homologue, anisole. An analysis is suggested on the basis of upper state frequencies, 159, 344, 354, 704, 907, 952, 1 263 and 1 542 cm^{-1}. These are compared with the Raman frequencies. *v–v* transitions giving difference frequencies 23 and 35 cm^{-1} have been established. A.

535.343.4

9382. Emission of radiation from diatomic gases. II. Experimental determination of effective average absorption coefficients of CO. S. S. Penner and D. Weber. *J. Appl. Phys.*, **22**, 1164–7 (*Sept.*, 1951).

For Pt I, see Abstr. 7107 (1950). Empirical evidence obtained for CO at room temperature, which supports the use of average absorption coefficients for entire vibration-rotation bands, is examined. The existence of an average apparent absorption coefficient for data obtained with inadequate spectral resolution is demonstrated. Semi-quantitative evidence at elevated total pressures and small optical densities for the use of a constant absorption coefficient equal to the ratio of integrated absorption to effective band width is described. These results serve as direct support for a proposed simplified method for radiant-heat-transfer calculations. A.

535.343.4–14

9383. Pressure broadening of an ammonia inversion line for foreign gases. J. Weber. Letter in *Phys. Rev.*, **83**, 1058 (*Sept.* 1, 1951).

The collision diameter for microwave pressure broadening in NH_3 for $D_2 > H_2$ as expected for NH_3 dipole—H_2 quadrupole interaction while the diameter for $NH_2D < NH_3$ due to the smaller average dipole and the absence of rotational resonance.

D. H. WHIFFEN

535.343.4–14

9384. Resonant absorption of oxygen at 2·5 millimeter wavelength. R. S. Anderson, C. M. Johnson and W. Gordy. Letter in *Phys. Rev.*, **83**, 1061 (*Sept.* 1, 1951).

The single line of the $J_{0\rightarrow 1}$ $K = 1$ transition in O_2 is observed at 118 745·5 Mc/s and its Zeeman splitting is discussed. D. H. WHIFFEN

535.343.4–14

9385. A method for reducing the Doppler breadth of microwave absorption lines. G. Newell, Jr, and R. H. Dicke. Letter in *Phys. Rev.*, **83**, 1064 (*Sept.* 1, 1951).

Details of an arrangement whereby a low frequency spatially periodic Stark field may limit coherent reflection to molecules moving with a velocity equal to the phase velocity of the Stark wave. The Doppler width is much reduced in consequence and a line width as low as 7 kc/s was obtained. D. H. WHIFFEN

535.343.4–15 : 545.82

9386. The quantitative determination of atmospheric gases by infra-red spectroscopic methods. I. Laboratory determination of the absorption of the 7·8 and 8·6 μ bands of nitrous oxide with dry air as a foreign gas. R. M. Goody and T. W. Wormell. *Proc. Roy. Soc. A*, **209**, 178–96 (*Oct.* 23, 1951).

New data on the effect of amount of gas, pressure of dry air and temperature upon the 7·8 and 8·6 μ bands of nitrous oxide, have been analysed in an attempt to find all the fundamental information required in order to use the 7·8 μ band for the quantitative determination of atmospheric nitrous oxide from telluric spectra. By taking rather more care than has been usual in the measurements of intensity the following conclusions can be reached: (1) It is possible to measure band intensities with a reasonable degree of accuracy. (2) The line broadening in a range of pressures, extending from 1 cm of Hg to 1 atm. of dry air, is caused by a collision process. (3) In this range of pressures, the shape of the wings of absorption lines is well represented by the Lorentz form. (4) The line width at 1 atm. pressure is the same for the 7·8, 8·6 and the 17 μ bands, and its most probable value is given by $2\alpha_L = 0{\cdot}314(\pm 0{\cdot}015)$ cm^{-1}. (5) At pressures below 5 mm of Hg, Doppler broadening becomes predominant. (6) The effect of temperature upon absorption agrees with theoretical prediction, excepting the dependence of collision diameter upon temperature. A.

535.35

9387. Imprisonment of resonance radiation in gases. II. T. Holstein. *Phys. Rev.*, **83**, 1159–68 (*Sept.* 15, 1951).

For Pt I, see Abstr. 929 (1948). The treatment is here extended to a second type of enclosure geometry—infinite cylinders—and to a variety of spectral line shapes. A.

535.371

9388. On the influence of reduction processes on the luminescence mechanism of fluorescent magnesium orthotitanate and ruby. E. KRAUTZ. *Abh. Braunschw. Wiss. Gesell.*, **3**, 55–60 (1951) *In German.*

The influence of reducing processes (H_2, N_2, vacuum) on the luminescence of magnesium orthotitanate activated by manganese and α-Al_2O_3 activated by chromium (ruby) is investigated at high temperatures. The altering of the ionization state of manganese activators is best studied by submitting the luminescence material to a vacuum treatment whereby a severe reducing of the basic crystal and the formation of nitrides and hydrides can be avoided. A.

535.371

9389. Theory of the mechanism of the scintillation of organic crystals. M. AGENO AND R. QUERZOLI. Letter in *Nuovo Cim.*, **8**, 512–14 (*July*, 1951) *In Italian.*

The theory postulates the transmission of energy from the exciting wave system to the crystals; it is based on the exponential nature of the curve of the decay of scintillation fluorescence with time, and the fact that the fluorescence increases with temp.

J. GRANT

535.371

9390. Fluorescence and absorption of crystalline stilbene. P. PESTEIL. *C.R. Acad. Sci., Paris*, **233**, 377–9 (*July* 30, 1951) *In French.*

535.371

9391. Quenching action of iron on luminescent zinc sulphide. N. ARPIARIAN. *C.R. Acad. Sci., Paris*, **233**, 387–9 (*July* 30, 1951) *In French.*

The quenching action of iron on the luminescence of ZnS–Cu phosphors is less than that of nickel and cobalt. After 60 sec decay at room temperature the afterglow becomes insensitive to iron inclusions.

G. F. J. GARLICK

535.371

9392. Thermoluminescence of zinc silicate phosphors activated with manganese and arsenic. J. R. NELSON AND J. H. BERBERT. Letter in *J. Opt. Soc. Amer.*, **41**, 644 (*Sept.*, 1951).

Addition of arsenic to Zn_2SiO_4–Mn phosphors produces an outstanding thermoluminescence effect in the peak at 243°K which for 0·01% As_2O_3 inclusion is 60 times its normal intensity. G. F. J. GARLICK

535.376 : 537.542

9393. Some considerations on the scintillation phenomena of organic crystals. M. AGENO. *R.C. Ist. Super. Sanità*, **14** (*No.* 6) 467–72 (1951) *In Italian.*

Existing work on comparative measurements of the scintillation phenomena produced in organic crystals by the action of γ-rays or of high-velocity ionizing particles, is reviewed. It throws little light on the mechanism of the phenomenon, because it is possible only to observe a restricted and arbitrary range of emitted frequencies, and because of the lack of correction data. Future possibilities for recording scintillation phenomena are indicated. J. GRANT

535.39

9394. The effect of gradual light absorption in a film of non-negligible thickness. L. SILBERSTEIN. *J. Franklin Inst.*, **252**, 33–42 (*July*, 1951).

General formulae are derived for the optical densities of thick and thin emulsions whose light absorption is not negligibly small, and applied to the one- and two-quanta hypotheses. R. A. WEALE

535.415

9395. Light "beats"—a note on a work by E. Rüchardt. C. v. FRAGSTEIN. *Optik*, **8** (*No.* 7) 289–94 (1951) *In German.*

A previous conclusion by Rüchardt [Abstr. 6403 (1950)], that light beats are not possible, is shown to be based upon a false argument. Further consideration shows that light beats and light interference in a Fizeau type interferometer with moving mirrors are identical. R. W. FISH

535.417

9396. Applications of multiple-beam interferometry. C. F. BRUCE. Letter in *Nature, Lond.*, **168**, 472 (*Sept.* 15, 1951).

A reply to comments made by S. Tolansky [Abstr. 6895 (1951)] on two earlier short publications by C. F. Bruce and others. S. TOLANSKY

535.417 : 532.72

9397. On the use of Rayleigh–Philpot–Cook interference fringes for the measurement of diffusion coefficients. H. SVENSSON. *Acta Chem. Scand.*, **5**, 72–84 (1951).

The interference refractometer has been successfully used for the measurement of diffusion coefficients and a detailed description is given of a method for the determination of the maximum derivative of the refractive index. The influence of the optical correction and relative aperture of the cylindrical lens is discussed. Systems in which the cylindrical element works at a low relative aperture, allow simple lenses to be used. See also Abstr. 7782 (1950). R. W. FISH

535.42

9398. On the diffraction theory of Gaussian optics. H. BREMMER. *Commun. Pure Appl. Math.*, **4**, 61–74 (*June*, 1951).

Diffraction theory is developed for objects with arbitrary structure, and is based on rigorous solutions of the wave equation instead of the conventional approximation of Kirchhoff's formula. The similarity of wave functions in the object plane and in the corresponding paraxial image plane proves to be connected with Neumann's integral theorem for Bessel functions in place of the Fourier identity as in Kirchhoff's approximation. Another solution accounts for the effects of optical aberrations and of limited apertures. R. W. FISH

535.42

9399. On the half-plane diffraction problem. F. G. FRIEDLANDER. *Quart. J. Mech. Appl. Math.*, **4**, 344–57 (*Sept.*, 1951).

The diffraction of an arbitrary 2-dimensional disturbance by a semi-infinite plane screen is considered. It is shown that the solution, at all points of space, can be obtained by a modification of the method developed by Hadamard for Cauchy's problem. The diffraction of the disturbance represented by Hadamard's "elementary solution" is discussed, and a simple expression for the diffracted disturbance is found; its Laplace transform agrees

with the Green's functions derived from Sommerfeld's 2-valued solutions of the wave equation. A.

535.42 : 534.26 : 538.566

9400. Diffraction and reflection of pulses by wedges and corners. J. B. KELLER AND A. BLANK. *Commun. Pure Appl. Math.*, **4**, 75–94 (*June*, 1951).

By combining the results of Luneberg, on the propagation of electromagnetic discontinuities, with Busemann's conical flow method for solving the wave equation, exact, explicit solutions of the 2- or 3-dimensional diffraction of pulses by wedges and corners are obtained. The method can be extended to diffraction by a cylinder of polygonal cross-section and by a grating. The results also apply to acoustic problems. R. W. FISH

535.551

9401. On certain invariant contour integrals in photoelasticity. F. TEISSIER DU CROS. *C.R. Acad. Sci., Paris*, **233**, 282–3 (*July* 23, 1951) *In French.*

The complex function $M(x, y) = Re^{-i\alpha}/2$, where R is the radius of the Mohr circle, may be evaluated throughout the specimen from standard measurements. The note sets out a number of contour integrals (topological invariants, each divisible into 2 real invariants) which derive from M and its partial derivatives, and states their uses. A. J. KENNEDY

535.566.2

9402. Optical anisotropy of molecules of benzene and of nitrobenzene dissolved in carbon tetrachloride. S. KERAMSI, R. LOCHET AND A. ROUSSET. *C.R. Acad. Sci., Paris*, **233**, 379–81 (*July* 30, 1951) *In French.*

The molecular anisotropy of C_6H_6 in CCl_4 is independent of concentration for dilute solutions but decreases for solutions above 0·25 molar, the values being of the order of half that of benzene vapour. For nitrobenzene the anisotropy increases steadily with concentration. Explanations of these variations are advanced. C. B. ALLSOPP

535.568 : 545.8

9403. Automatic measurement of optical rotation. G. B. LEVY. *Analyt. Chem.*, **23**, 1089–92 (*Aug.*, 1951).

535.6.08

9404. C.I.E. chromaticity co-ordinates. M. BAUDYŠ. *Elektrotech. Obz.*, **40** (*No.* 1) 5–14 (1951) *In Czech.*

Describes the C.I.E. system of colorimetry and its use for colour description and specification. The derivation of colour co-ordinates from spectral distribution data is explained. A.

535.6.08 : 535.247.4

9405. A photo-electric comparator for colorimetric determinations. T. F. STANTON. *Fuel*, **30**, 208–11 (*Sept.*, 1951).

Describes the construction and operation of a simple and robust photoelectric absorptiometer suitable for many routine colorimetric determinations. The design allows two separate beams of light to fall on a split photoelectric cell whose output is balanced on a bridge circuit to obtain zero reading on a galvanometer. The dial reading of a variable resistance in this circuit is related to the light absorptive power of the solution under examination. Phosphorus in coal and coke ash has been determined using the absorptiometer and the results compare favourably with those using the B.S. method and a widely used type of absorptiometer. A.

535.65

9406. Modern problems of colorimetry. W. D. WRIGHT. *Proc. Phys. Soc., Lond. B*, **64**, 537–49 (*July*, 1951).

A general review of the present position in colorimetry and a statement of outstanding problems, particularly (*a*) the use of a uniform chromaticity chart, (*b*) the dissemination of a knowledge of colour among those working in fields where colour measurement is important, (*c*) the need for simpler and cheaper instruments, (*d*) the subjective phenomena of colour adaptation. J. W. T. WALSH

535.662

9407. On the irradiation of natural coloured rock-salt crystals with α-particles from RaF. L. WIENIGER AND N. ADLER. *S.B. Öst. Akad. Wiss. Abt. IIa*, **159** (*No.* 3–6) 83–95 (1950) *In German.*

Absorption in the F- and M-bands increases with irradiation time and reaches a saturation value corresponding to about 2×10^{19} colour centres/cm^3. The total energy E absorbed by the crystal for the production of one centre increases with the number N of centres: for $N = 6\cdot6\times10^{17}$, $E = 4\,600$ eV; for $N = 1\cdot5\times10^{19}$, $E = 1\cdot2\times10^5$ eV. It is suggested that natural coloured crystals may have been produced by the presence of RaF in deep waters. L. PINCHERLE

535.662

9408. On the irradiation of natural coloured rock-salt crystals with α-particles from RaF. L. WIENIGER. *S.B. Öst. Akad. Wiss. Abt. IIa*, **159** (*No.* 3–6) 113–28 (1950) *In German.*

The investigation of the previous paper is extended to crystals coloured by the presence of colloidal Na. In these samples the irradiation produces more F-centres than in uncoloured crystals. A displacement of the absorption maximum suggests that the irradiation reduces the size of the colloidal particles. Differences between crystals from different sources are pointed out. L. PINCHERLE

535.662.1 : 548.0

9409. Investigation of the properties of coloured potassium chlorate crystals. G. CARIO, J. EULER AND H. FRICKE. *Abh. Braunschw. Wiss. Gesell.*, **3**, 21–33 (1951) *In German.*

On crystallizing $KClO_3$ from a solution, there are formed monocline crystal plates remarkable for their bright reflection colours. Previous publications by other authors explained this appearance to be an interference phenomenon, caused by strata structure of the plates consisting of twin lamellae with alternating refractive index. The present investigation shows that the accordance of the measured values with a simple lattice theory is satisfactory up to angles of incidence of 45°. For still greater angles the double refraction of $KClO_3$ must be accounted for. In a paper by G. Becker to be published soon it will be shown that even the phenomena in polarized light can be explained by a theory of such type. Further discussion shows that discrepancies caused by lattice disturbances are of minor importance. A further

publication will deal with the question of the mechanism of formation of these regularly structured strata containing up to 1 000 such reflecting layers. A.

535.822.9

9410. Multiple microscopic light slit. E. MENZEL. Note in *Naturwissenschaften*, **38** (*No.* 14) 332–3 (1951) *In German.*

A multiple slit version of the Schmaltz light slit microscope for the investigation of surface irregularities is described. The microscope is arranged normal to the surface so that a large field is in focus. Differences of depth of $0{\cdot}1\ \mu$ are said to be recognizable with this instrument. R. W. FISH

535.826.9

9411. The method of shadow-casting in photomicrography. D. L. BHATTACHARYA. *Indian J. Phys.*, **25**, 145–51 (*March*, 1951).

A discussion of the shadow-casting method in increasing contrast of unstained biological objects for use in optical microscope is presented. A calculated quantity of silver is deposited on the specimen at an angle in this technique and estimates are made for the thickness that can be profitably deposited to provide proper opacity and contrast. Optical micrographs of the protozoa L. Donovani when shadow-cast with different thickness of silver are reproduced. A.

535.89 : 545.822

9412. Igniting an arc for spectrographic analysis in vacuum. A. J. MITTELDORF. Letter in *J. Opt. Soc. Amer.*, **41**, 646–7 (*Sept.*, 1951).

Separation of the electrodes for striking the arc is effected by the fall of the lower one when a Wood's metal pin is melted by the heat of the short-circuit current.

HEAT 536

536.2.02

9413. The application of relaxation methods to the solution of non-elliptic partial differential equations. I. The heat-conduction equation. D. N. DE G. ALLEN AND R. T. SEVERN. *Quart. J. Mech. Appl. Math.*, **4**, 209–22 (*June*, 1951).

A method is described for bringing the heat conduction equation within the scope of relaxation. The underlying idea is introduced in one dimension only. A.

536.2.083

9414. How to choose the diameter in measurements of the thermal conductivity by the bar methods. P. VERNOTTE. *C.R. Acad. Sci., Paris*, **233**, 294–6 (*July* 23, 1951) *In French.*

The bar method assumes that the cross-sections are isothermal surfaces. It is shown that $\varepsilon = hR/2\lambda$, where h, R and λ are the surface leakage coefficient, the radius and thermal conductivity respectively of the bar, is, to a first approximation, a measure of the departure from isothermal cross-sections. Since h can, in most cases, be put equal to $2\times10^{-4}\ R^{\frac{1}{2}}$ in c.g.s. units, $R = 10^8\ \varepsilon^2\lambda^2$. Further, if l is the length, R is $0{\cdot}0055$ and $0{\cdot}00031\ l^{4/3}\lambda^{-2/3}$ for a long and short bar respectively. Hence, equating the two expressions for R, it is shown that it is always possible to obtain a fairly accurate value for λ using a reasonable R even for a bar of very small conductivity.

S. WEINTROUB

536.21

9415. A note on the existence of a solution to a problem of Stefan. G. W. EVANS, II. *Quart. Appl. Math.*, **9**, 185–93 (*July*, 1951).

A previous paper [Abstr. 5346 (1951)] considered the computation of a solution to this problem. The present mathematical paper establishes the existence and uniqueness of the solution. E. H. DOCK

536.21 : 548

9416. Thermal conductivity of dielectric crystals: the "Umklapp" process. R. BERMAN, F. E. SIMON AND J. WILKS. *Nature, Lond.*, **168**, 277–80 (*Aug.* 18, 1951).

Correlates experimental results on temperature-dependence of thermal conductivity of quartz, sapphire and diamond single crystals, and on crystals of solid He at different densities, with (1) prediction of Debye and Peierls that thermal conductivity $\propto 1/T$ at high temperatures; (2) Peierls' theory (and modifications due to Klemens) of the "Umklapp" process leading to exponential increase in thermal conductivity with lowering of temperature; (3) "size effect" coming into play at still lower temperatures and resulting in the thermal conductivity becoming proportional to the smallest dimension of the specimen and to T^3; and (4) Pomeranchuk's theory of limitation of phonon mean free path by departures of lattice from regularity. R. B. DINGLE

536.252

9417. The surface elevation in cellular convection. H. JEFFREYS. *Quart. J. Mech. Appl. Math.*, **4**, 283–8 (*Sept.*, 1951).

A theoretical explanation is given of the fact that, in cellular convection in a fluid heated below, the surface is depressed over the rising currents. A discrepancy remains between theory and observation. A.

536.413.2

9418. Linear thermal expansion of artificial graphites to 1 370°C. M. D. BURDICK, B. ZWEIG AND R. E. MORELAND. *J. Res. Nat. Bur. Stand., Wash.*, **47**, 35–40 (*July*, 1951).

536.42

9419. Relationships between melting temperatures and boiling temperatures of elements. A. BERTON. *C.R. Acad. Sci., Paris*, **233**, 151–4 (*July* 9, 1951) *In French.*

Boiling temperatures of elements when plotted against their melting temperatures give for many groups of elements points lying on a straight, or nearly straight, line. Apart from alkali metals, alkaline earth metals and metalloids, for most groups of elements (e.g. inert gases, halogens, Mg–Zn–Cd–Hg, Pt and Fe triads) the slope of the straight line is = 1.

F. LACHMAN

536.421.4 : 532.782

9420. Freezing of supercooled water. A. W. BREWER AND H. P. PALMER. *Proc. Phys. Soc., Lond. B*, **64**, 765–73 (*Sept.*, 1951).

Rau has claimed that, by repeated freezing and thawing, the temperature to which a drop of water

supercools before freezing can be lowered and, with special care, the freezing temperature can be reduced to −72°c. This is claimed to be the temperature of spontaneous nucleation of ice. At that temperature the ice forms in rectangular crystals which also melt at −72°c. This note describes a careful attempt to repeat Rau's work, which could not be done except by deliberate contamination, and it is presumed that Rau's apparatus was faulty and his drops were contaminated by his cooling fluid. Information is given concerning the reproducibility of the freezing temperature of individual drops when repeatedly frozen and thawed. Rau's rectangular crystals have been observed in strong alcohol solutions, but no information concerning their nature has been obtained. A.

536.423.15 : 537.534.72

9421. The measurement of low vapor pressures by means of a mass spectrometer. A. W. Tickner and F. P. Lossing. *J. Phys. Coll. Chem.*, **55**, 733–40 (*May*, 1951).

Partial pressure measurements avoid the effects of volatile impurities, which make total pressure determination inaccurate below 1 mm with the lower hydrocarbons. 11 hydrocarbons and CO_2 have been investigated from 10 mm to 10^{-3} mm. Samples were admitted from a thermostat consisting of an electrically heated container surrounded by liquid nitrogen or liquid hydrogen. Peak heights varied linearly with partial pressure up to 0·04 mm; above 0·03 mm equilibrated vapour was expanded from a calibrated volume. A complete curve could be obtained in 8–10 hr from only 0·02 mole of material. The design and operation of the thermostat are described in detail, and the results are presented in tables and graphs. T. G. PICKAVANCE

536.423.4

9422. Spontaneous condensation of water vapour in expansion chamber experiments. B. J. Mason. *Proc. Phys. Soc., Lond. B*, **64**, 773–9 (*Sept.*, 1951).

When clear, saturated air is subjected to a sufficiently large adiabatic expansion, small water droplets arise spontaneously from the vapour. An equation is derived for the growth rate of a droplet in an atmosphere of given supersaturation and temperature. This is used in conjunction with the Becker–Döring theory of nucleation to calculate the supersaturation and the concentration of droplets at successive time intervals during a cloud-chamber expansion, allowance being made for warming of the air by liberation of the latent heat of condensation. For large expansion ratios, the supersaturation attains a maximum and the droplet concentration a sensibly constant value before the end of the expansion. The computed value of this maximum droplet concentration is in acceptable agreement with the recent observations of Frey. The experimental results appear incompatible with Tolman's recent theory concerning the variation of surface tension with droplet radius. The predicted rates of droplet growth agree well with recent measurements made by Hazen. A.

536.424

9423. The allotropic transformation of hafnium. P. Duwez. *J. Appl. Phys.*, **22**, 1174–5 (*Sept.*, 1951).

The existence of an allotropic transformation in Hf, suggested by Zwikker in 1926, has been confirmed. The transformation temperature is 1 310 ± 10°c. The high temperature beta-form is probably body-centred cubic. A.

536.445

9424. Volume behaviour of diluted gaseous solutions near the critical point of the pure solvent. D. Yu. Gamburg. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 459–60 (1951) *In Russian.*

The determination of partial molal volumes of C_6H_6 dissolved in compressed CO_2 at 31·1°c, by using the author's differential volumenometer method [*J. Phys. Chem., USSR*, **24**, 272 (1950)], yielded the following results: 1 580, 515, 190 and −192 cm³ for pressures of 5·84, 15·50, 30·00 and 49·10 atmos., respectively. The negative value obtained is in agreement with the classical theory of critical states. F. LACHMAN

536.461

9425. Observations on anomalous burner flames. W. Jost and L. Sieg. *Z. Naturforsch.*, **6a**, 403–5 (*July*, 1951) *In German.*

Direct and shadow photographs are reproduced showing flames of benzene vapour burning in air diluted with varying amounts of CO_2 and N_2. To ensure stability and symmetry the premixed fuel and oxidant were passed through a tube 1 m long and 29 mm dia., terminating in a nozzle 9 mm dia. at which the gas was ignited; in some expts. the flame was surrounded by a glass tube to shield it from atmospheric disturbances. In spite of these precautions asymmetric flames were formed, the shape of which was stable against transient disturbances by external air currents. In other cases the flame took the form of a fluted cone. It is suggested that these anomalous quasi-stable flame shapes are those for which the rate of entropy production is the highest of a series of minimum values; such a state would not be permanent, but subject to oscillation initiated by atmospheric disturbances. A. SCHOFIELD

536.48

9426. On the probable existence of two states of helium in the gaseous phase. J. P. E. Duclaux. *C.R. Acad. Sci., Paris*, **233**, 292–4 (*July* 23, 1951) *In French.*

Using equations given in a previous paper [Abstr. 8708 (1951)] the specific volumes of gaseous He below the λ point are deduced from experimental latent heat and liquid specific volume values. These are not in agreement with those obtained by extrapolation of equations valid above the λ point. From this it is deduced that gaseous as well as liquid He exists in two states below the λ point. F. E. HOARE

536.48

9427. Theory of liquid He^3. I. Pomeranchuk. *J. Exp. Theor. Phys., USSR*, **20**, 919–24 (*Oct.*, 1950) *In Russian.*

A theory assuming excitations obeying F.D. statistics shows that at temperatures much less than the degeneracy temperature (~ 5°K), the specific heat is $\propto T$, viscosity $\propto T^{-2}$ and thermal conductivity $\propto T^{-1}$. Between 10^{-7} °K (≡ interaction energy of nuclear spins) and about 1°K, the vapour pressure

should fall with increase in temperature because heat should then be absorbed in isothermal solidification. R. B. DINGLE

536.48

9428. Measurement of vapour pressure of solutions of He^3 in He^4. B. N. Eselson, B. G. Lazarev and N. E. Alekseevskiĭ. *J. Exp. Theor. Phys., USSR*, **20**, 1055–6 (*Nov.*, 1950) *In Russian.*

When the quantity of condensed liquid is small, allowance must be made for the He^3 passing into the gas phase. Raoult's law is obeyed for concentrations of He^3 up to 2% at least. R. B. DINGLE

536.48

9429. A note on the pressure equation of the two fluid model of helium II. T. Usui. *Progr. Theor. Phys.*, **6**, 244–50 (*March–April*, 1951).

This equation is re-derived and applied to the experiments on the thermal Rayleigh disk by Pellam and Morse [Abstr. 6452 (1950)] and on the thermal Pitot tube by Pellam [Abstr. 7957 (1950)]. H. LONDON

536.48

9430. The flow of liquid helium II through wide capillaries. K. R. Atkins. *Proc. Phys. Soc., Lond.*, A **64**, 833–44 (*Sept.*, 1951).

A study has been made of the isothermal, pressure-induced flow of liquid He II through glass capillaries of bore between $2{\cdot}6\times10^{-3}$ and 4×10^{-2} cm. The critical velocity is found to be less than 1 cm sec^{-1} except, possibly, in the case of the finest capillary. The theory that there is a force of mutual friction between the normal and superfluid components predicts the correct order of magnitude for the flow velocities, but there are discrepancies which suggest the existence of some other source of friction. A.

536.48

9431. The velocity of first sound in liquid helium. K. R. Atkins and C. E. Chase. *Proc. Phys. Soc., Lond. A*, **64**, 826–33 (*Sept.*, 1951).

The velocity u_1 of ordinary sound in liquid He has been measured in the temperature range from 1·2°K to 4·2°K. Its value extrapolated to 0°K is compared with the velocity u_2 of second sound at 0·1°K and a slight departure from the Landau relation $u_2 = u_1/\sqrt{3}$ is indicated. The behaviour of u_1 in the neighbourhood of the λ-point has been studied in detail. A.

536.48 : 538.222

Investigation of nuclear effects in paramagnetic single crystals at very low temperatures. *See Abstr.* 9602

536.483

9432. An oil-free gas-tight compressor. G. O. Jones. *J. Sci. Instrum.*, **28**, 313–16 (*Oct.*, 1951).

A new non-contaminating piston-type compressor is described. A highly flexible rubber diaphragm behind the piston acts as a gas-tight gland and also separates the lubricated parts which drive and guide the piston from the space swept out by the piston itself, in which there is no fluid lubricant. The diaphragm is specially protected against pressure differences by suitable connections. The experimental 2-stage model constructed, which has been used in the liquefaction of helium, is based on a 2-cylinder motor-cycle engine. Details are given of its performance. A.

536.52 : 535.23.08

9433. Measurement of wall temperatures. W. Koch. Letter in *J. Sci. Instrum.*, **28**, 319–20 (*Oct.*, 1951).

By means of a modification to a Kipp and Zonen radiation measuring apparatus (type E 11) wall temperatures differing from ambient air by < 5°C can be measured to $\pm\ 0{\cdot}15$°C.

536.631 : 538.222

Thermal and magnetic properties of caesium titanium alum. *See Abstr.* 9603

THERMODYNAMICS 536.7/.8

536.7 : 530.162

9434. On the formalism of thermodynamic fluctuation theory. R. F. Greene and H. B. Callen. *Phys. Rev.*, **83**, 1231–5 (*Sept.* 15, 1951).

From the statistical mechanical occupation probability of microstates Einstein has inferred a distribution function for the macroscopic states of a canonical ensemble. The conventional theory of thermodynamic fluctuations proceeds by making certain series expansions in the Einstein function and by dropping all cubic and higher order terms. In this paper it is established that: (*a*) The correlation moments for the extensive thermodynamic parameter fluctuations may be computed directly from the distribution function for the microstates, without introducing an intermediate macroscopic distribution function. (*b*) These same moments can be evaluated from the Einstein function without making series expansions or invoking approximations. (*c*) All moments computed by methods (*a*) or (*b*) agree exactly. (This may be taken as an alternative derivation of the Einstein function.) (*d*) The second moments computed by the conventional method are correct, but all higher moments are incorrect. A.

536.75 : 523.11

9435. Increase of entropy in an infinite universe. I. R. Plotkin. *J. Exp. Theor. Phys., USSR*, **20**, 1051–4 (*Nov.*, 1950) *In Russian.*

An attempt at confuting the conclusion of Stanyukovich [*Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 793 (1949)]: "had a universe consisted of a finite plurality of particles of one class (e.g., molecules) . . . then, after a finite number of interactions between the particles . . . the state of equilibrium would ensue for the whole universe." It is demonstrated that the law of the increase of entropy is not valid for an infinite universe as well as for any part of it that contains an infinite number of particles, and that this fact does not depend upon the concrete structure of the universe. Hence a state of equilibrium for the whole universe not only is impossible, but does not make any sense at all. It is claimed that attempts at applying to the whole universe the conclusions of the second law of thermodynamics have no scientific foundation.

F. LACHMAN

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.221

9436. Static electrification of solid particles by spraying. S. J. Czyzak and D. T. Williams. *Science*, **114**, 66–8 (*July* 20, 1951).

The change in potential of a polyethylene sheet which has previously been charged, is measured when sprays of various liquids and powders are deposited. No change in potential occurs in the case of water, carbon tetrachloride and glycerine sprays, but with acetone, charcoal, starch and a 1 : 1 mixture of charcoal and starch an exponential decay of potential is observed, the rate of decay being dependent on the material used and (in the case of charcoal) on the density of the spray. E. RUSHTON

537.224 : 621.319.4

9437. Electrical charge storage in polystyrene capacitors. L. A. Matheson and V. J. Caldecourt. *J. Appl. Phys.*, **22**, 1176–8 (*Sept.*, 1951).

Measurements on charge storage in polystyrene capacitors over a period of months indicate that exceptionally fine capacitors may be made of polystyrene film when sufficient care is taken. Very small charge "soakage" occurs in such a capacitor and charges may be retained for times of the order of one hundred years and possibly longer. The specific resistance approaches 10^{22} ohm cm when measured over a period of months. The power factor of polystyrene is about 10^{-4} for frequencies of 10^{-1} to 10^{-6} c/s with a tendency to increase at the lowest frequencies and with a possible peak at still lower frequencies. The difference between charge soakage during charging and the charge recovery after shorting indicates some nonreversible current flow when measurements are made over several months' time.

A.

537.226

9438. Theory of ferro-electricity. G. A. Smolenskiĭ and R. E. Pasynkov. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 431–4 (1951) *In Russian.*

Limitations and errors of theories of Mason and Mathias [Abstr. 2492 (1949)], Devonshire [Abstr. 956 (1950)] and Slater [Abstr. 7972 (1950)] are shown in mathematical considerations. J. LUKASZEWICZ

537.226

9439. On mechanical action in dielectrics. R. Cade. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 665 (*July*, 1951).

It is shown that the Livens and Smith–White theory gives the same result as the Maxwell–Helmholtz theory only for the special case where the dielectric is rigid and fills the whole region considered. For other cases additional forces must be considered.

C. A. HOGARTH

537.226

9440. Dielectric polarization and relaxation of solutions and mixtures of polar (including associated) materials with the assumption of the Onsager inner field. E. Fischer. *Z. Naturforsch.*, **6a**, 446–55 (*Aug.*, 1951) *In German.*

Theoretical calculations showing the behaviour of the dispersion and mean relaxation times under various assumptions of the nature of the association in mixtures. D. H. WHIFFEN

537.226 : 541.132

9441. Contact distances of ion pairs in the isomeric dichloroethanes. K. H. Stern, F. Healey, Jr, and A. E. Martell. *J. Chem. Phys.*, **19**, 1114–17 (*Sept.*, 1951).

The effective dielectric constant of ethylene chloride is calculated from known dissociation constants of various ion pairs in ethylene and ethylidene chloride according to the method of Denison and Ramsey. The average value of the effective dielectric constant is used for the calculation of contact distances of various ion pairs in ethylene chloride. The variation of contact distance with size and structure of the ions is discussed. A.

537.226.2

9442. Tables of electric dipole moments. L. G. Wesson; **Measurements of dielectric constant and dipole moment of gases by the beat-frequency method.** J. G. Jelatis. *Overseas Res. Rep.*, 225/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv. Wash., PB* 110296, *PB* 110300.

In the first report substances for which electric dipole moments have been found in the literature are presented in tabulated form in three groups: (1) inorganic substances; (2) metal-organic compounds; and (3) organic compounds. The arrangement of 1 and 2 is alphabetical, while 3 is organized according to the empirical formulae. Numbers are enclosed in parenthesis following the dipole values, referring to a bibliography (1919–1946) of 774 items at the end of the table. An author index to the bibliography is included.

In the second the beat-frequency method for measuring the dielectric constant and dipole moment of gases is critically investigated. It is thought that the wide discrepancies in the data of previous observers are due to the neglect of certain stray components in the circuits involved. An equipment taking these factors into consideration is described, and a method for "absolute" standardization of the instrument is given. Results of dielectric constant and dipole moment measurements for several gases are presented and compared with previous data. Diagrams and a list of references are included. A.

537.226.2

9443. Ferro-electric properties of some solid solutions. G. A. Smolenskiĭ, M. A. Karamyshev and K. I. Rozgachev. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 1) 53–6 (1951) *In Russian.*

Barium zirconate and stannate by themselves do not appear to be ferro-electric. In solid solutions with $BaTiO_3$ in given concentrations and temperatures they exhibit ferro-electric properties. These have been investigated and are expected to be analogous to other solid solutions whose components have electrostriction of opposite signs.

J. LUKASZEWICZ

537.226.2

9444. Dielectric properties of salt solutions at ultra-high frequencies. R. SATYANARAYANA AND S. R. KHASTGIR. *Indian J. Phys.*, **25**, 163–81 (*April*, 1951).

The properties of (1) sodium chloride, (2) magnesium chloride, (3) potassium chloride, and (4) copper sulphate solutions over the range 60–110 Mc/s were studied by employing a Lecher-wire system terminating at the input end by a condenser filled with each of the solutions. The dielectric constant of the solutions was found to increase, attaining a saturation value at a particular concentration (0·4–0·6%), except in the case of copper sulphate solution. The ultra-high frequency absorption was studied by drawing the space-resonance curves with different concentrations of the salt solution. Absorption curves were then drawn from which the frequencies of the maximum absorption for certain concentrations were found. From the observed values of the frequencies of maximum absorption the relaxation times were determined for these concentrations by applying Debye's formula. With the values of relaxation time obtained from the absorption data, Debye's dispersion, absorption and loss-tangent curves have been drawn. The values of relaxation time were also computed from Debye–Falkenhagen formula for comparison. In the case of copper sulphate, there was discrepancy. The values of the high-frequency electrical conductivity of sodium chloride have also been calculated for different concentrations for three different frequencies within the experimental range. A.

537.226.2

9445. On the absorption of u.h.f. radio waves in some aliphatic ketones dissolved in non-polar solvents. S. N. SEN. *Indian J. Phys.*, **25**, 187–96 (*April*, 1951).

This has been studied in the frequency range 250–510 Mc/s. It has been observed that the heights of the absorption peaks decrease greatly in all cases when the pure liquid is dissolved in the solvent to make even an 80% solution and the curves become flatter and flatter as the dilution is increased, except in the case of ethyl isobutyl ketone in which case the height of the peak tends to attain a constant value with increase of dilution. It is further observed that the maximum in the absorption curve shifts towards higher frequencies both with dissolution and increase in dilution of the solution. It is suggested that the diminution in the height of the absorption peak is due to breaking of associated groups of molecules and the shift is due to change in the internal viscous forces acting on the polar molecules caused by the surrounding non-polar molecules of the solvent. A.

537.226.2

9446. On the papers of S. K. Kulkarni Dzhatkar (Jatkar) (*et al*) on the theory of polarization of dielectrics. V. I. ODELEVSKIĬ. *J. Exp. Theor. Phys., USSR*, **21**, 652–5 (*May*, 1951) *In Russian.*

See Abstr. 6197–9 (1951).

537.226.2

9447. The dielectric constant of argon at 25°C and 125°C for pressures up to 2 700 atmospheres. A. MICHELS, C. A. TEN SELDAM AND S. D. J. OVERDIJK. *Physica*, **17**, 781–7 (*Aug.*, 1951).

The heterodyne beat method was used. The influence of parasitic capacities and inductivities were reduced to a minimum and corrections applied for the remaining effects. From the data obtained, the Clausius–Mosotti function has been calculated. A.

537.226.2

9448. Variation of dielectric constants of ionic crystals with pressure. S. MAYBURG. Letter in *Phys. Rev.*, **83**, 1072 (*Sept.* 1, 1951).

See Abstr. 7973 (1950), 5393 (1951). Disagreement is explained by a difference in the definitions of compressibility.

537.226.2 : 538.569.2.047 : 615.84

Dielectric behaviour of human tissues at microwave frequencies. *See Abstr.* 9878–9

537.226.2 : 548.3

New varieties of monocrystals of barium titanate. *See Abstr.* 9807

537.226.3

9449. A transient method for measurement of dielectric polarization. D. W. DAVIDSON, R. P. AUTY AND R. H. COLE. *Rev. Sci. Instrum.*, **22**, 678–82 (*Sept.*, 1951).

A transient method is described which measures the equivalent of the polarization following application of a step voltage by recording the changing current resulting from a linearly rising potential across a dielectric cell. The circuits described permit recording over intervals from 10^{-3} sec to several seconds and are intended for use with cells employing guard electrodes. Examples of results on dielectric relaxation in solids are given and limitations of the method discussed. A.

537.226.31

9450. Dielectric relaxation in dilute solutions of polar molecules in a non-polar liquid. S. ZIENAU. *Rep. Brit. Elect. Res. Ass.* (*Ref. G/T240*) 8 *pp.* (1950).

The relaxation behaviour of such solutions is usually discussed with the aid of the mode proposed many years ago by Debye. In this report a generalized model with two competing relaxation processes is investigated in a preliminary way. A.

537.228 : 538.6

9451. Electric and magnetic forces: a direct calculation. I. W. F. BROWN, JR. *Amer. J. Phys.*, **19**, 290–304 (*May*, 1951).

The forces acting on an arbitrary portion of an electrically or magnetically polarized body are calculated without introduction of energy arguments, of an atomic model of the polarization, or of assumptions in regard to the physical significance of the macroscopic field vectors within polarized matter. It is pointed out that a magneto-mechanical formula derived by use of Amperian currents and one derived by use of magnetic poles will, in general, require different "stress" systems in a given physical situation, because a part of the force that is included in the long-range force in one calculation is attributed to stresses in the other. In the present treatment, dipole-dipole interactions are taken as fundamental; poles and Amperian currents are regarded as purely formal devices; and the two are treated on an equal footing, so that two equivalent sets of formulae are obtained. These general formulae are then specialized to the case of a fluid. Formulae relating to electrostriction

and to the effect of immersing a body in a fluid are derived; their relation to the traditional formulae (based on energy arguments) is discussed. A.

537.228 : 538.6

9452. Electric and magnetic forces: a direct calculation. II. W. F. BROWN, JR. *Amer. J. Phys.*, **19**, 333–50 (*Sept.*, 1951).

The principles developed in the preceding part are illustrated by applying them to the problem of a sphere, with arbitrary material properties, immersed in a fluid with linear dielectric properties, in an applied electric field that is symmetric about an axis but is otherwise arbitrary. The long-range electric force and the short-range force due to fluid pressure are calculated separately; the sum of these is what is usually calculated by the Maxwell stress method, and the resolution into two terms is admittedly not unique. Some general work and energy relations are developed; these are put into a form such that elementary thermodynamic principles can be applied directly, without resort to physical interpretations of the macroscopic field vectors. The application to magnetoelastic and piezoelectric phenomena is indicated. The standard formulae of piezoelectricity, as developed by Voigt, are shown to be correct only if the "stresses" occurring in them are given a particular one of several possible interpretations. A.

537.228.1

9453. Piezoelectric effect in lead zirconate. S. ROBERTS. Letter in *Phys. Rev.*, **83**, 1078 (*Sept.* 1, 1951).

Ceramic disks were polarized by a unidirectional electric field during cooling and showed a very small piezoelectric effect ($d_{33} \simeq 10^{-13}$ coulomb/newton). The polarity of the compression-induced field was the same as the polarizing field. See Abstr. 9835 (1951).

537.228.1 : 539.893

9454. Change of piezoelectric frequency of quartz under high pressure. A. MICHELS AND J. P. PEREZ. *Physica*, **17**, 563–4 (*May*, 1951) *In French.*

The resonant frequencies of AT and BT cut quartz crystals are measured under hydrostatic pressures ranging up to about 1 000 atmos. For the AT cut, the coeff. $\Delta f/f\,\Delta P$ is $+8{\cdot}03\times10^{-6}$ cm²/kg and for the BT cut $-2{\cdot}03\times10^{-6}$ cm²/kg. The magnitude of the change cannot be accounted for by changes in linear dimensions. The change in frequency with pressure offers a possible method of measuring high pressures. H. J. H. STARKS

537.228.1 : 621.317.37.018.1 : 621.396.611.21

9455. New methods for the determination of electric constants of vibrating piezo-electric crystals. F. G. VENTOURATOS. *Beama J.*, **58**, 227–30 (*Aug.*, 1951).

Two experimental methods for the determination of quartz crystal constants are described. The first, the crystal under test is connected across the grid and cathode terminals of an oscillator circuit. The $B+$ voltage of the oscillator is then removed and the oscillator vibrates freely for a certain time. By properly combining a single-stroke-time-base two-beam oscillograph with a recurrent circuit, a stationary pattern of dying-off oscillations appears on the screen. If a suitable timing wave is displayed on the second beam of the oscillograph, the duration of the vibration decay and therefrom the logarithmic decrement or the Q of the crystal is determined. The second method, the crystal under test is connected in a branch of a Belfils bridge fed by an oscillator tuned to exactly the crystal frequency. At this frequency the impedance of the crystal becomes practically equal to its equivalent resistance which is thus determined. A.

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 537.533 : 530.162 : 621.38

9456. On the theory of random noise. Phenomenological models. I. D. MIDDLETON. *J. Appl. Phys.*, **22**, 1143–52 (*Sept.*, 1951).

Three phenomenological models are considered from which can be constructed a macroscopic statistical description of varieties of electronic noise, of which shot, thermal and Barkhausen noise, electron multiplier and precipitation noise, clutter, ignition and impulsive random noise in general are representative examples. The models examined are: (A) Non-overlapping, periodic noise waves, common in pulse-time modulation and other communication schemes, where the amplitude, phase, duration and epoch in a period interval are subject to statistical variations; (B) non-overlapping, non-periodic disturbances, encountered in servomechanism operation and keyed-carrier communication techniques, for instance, which are like (A), but lack the basic periodic structure; and (C) Poisson noise, consisting of the superposition of independent, randomly occurring elementary impulses. Much of the electronic noise mentioned above belongs to this more comprehensive type, where overlapping of the basic pulses is the characteristic feature. Because all (second-order) moments are required in general for the analysis of noise in non-linear systems, the attempt is made here to determine explicitly on the basis of the appropriate model the second-order probability density W_2 in the important stationary cases. For noise of types (A) and (B) this appears impractical except in the simplest cases: only the lower order moments prove tractable. However, for (C) an explicit treatment is possible for impulsive random noise; nearly normal random noise, and for the limiting, normal random cases (of which shot and thermal noise are examples). The main features of the models (A–C) are discussed, and the general probability density $W_1(X_1, t_1; \ldots; X_s, t_s)$ in the non-stationary instances is formally constructed. A.

537.3 : 537.533 : 530.162 : 621.38

9457. On the theory of random noise. Phenomenological models. II. D. MIDDLETON. *J. Appl. Phys.*, **22**, 1153–63 (*Sept.*, 1951).

Part II is devoted to the detailed evaluation of the first and second (second-order) moments, namely, average values and the cross- and autocorrelation functions for stationary random noise waves for models (A–C), whose statistical description is given in Part I. From these in turn are determined the

cross- and autospectral intensities governing the distribution of energy in the random disturbances. Finally, the asymptotically normal distributions characteristic of the high density Poisson noise (C) are evaluated, together with higher order correction terms and their associated characteristic functions. A.

537.3 : 621.38 : 621.317.34

9458. The generation and measurement of low frequency random noise. R. R. Bennett and A. S. Fulton. *J. Appl. Phys.*, **22**, 1187–91 (*Sept.*, 1951).

Judgment of the performance of automatic control systems often involves a consideration of the behaviour of such systems in the presence of random noise. The noise may be of an undesirable nature, such as receiver noise, or it may represent an ensemble of statistical inputs which the system is to follow. Analytical techniques exist for determining the response of linear systems to noise inputs. However, no general methods are available for analysing non-linear systems subject to noise inputs. An electric analogue computer, together with a suitable source of noise, may be used to study non-linear systems. This paper describes an electronic noise generator designed for analogue computer or simulator use. Methods are discussed for measuring the important characteristics of low frequency noise, such as the mean value, spectral density, amplitude distribution and autocorrelation. Particular attention is devoted to the length of time necessary to establish satisfactory estimates of the properties of low frequency noise. A.

537.3 : 621.38 : 621.317.34

9459. The power spectrum of a narrow band noise passed through a nonlinear impedance element. J. L. McLucas and R. C. Raymond. *J. Appl. Phys.*, **22**, 1211–13 (*Sept.*, 1951).

The power spectrum of the current flowing through a non-linear impedance element excited by a narrow band of noise centred at 1·6 Mc/s has been measured experimentally from the audio range through the sixth harmonic band. A noise having the spectral shape of an error function with a standard deviation of 3·8 kc/s was generated by passing the current from a photomultiplier tube through several tuned amplifier stages. The noise was applied through an attenuator of 50 ohms characteristic impedance to a crystal diode. The current flowing in the diode passed through attenuators of 50 ohms characteristic impedance to the spectrum analyser. In the audio range, a conventional wave analyser was used, and in the remaining ranges, a calibrated radio receiver was used to measure the spectral distribution of output power. The results are in qualitative agreement with the theory of Middleton. A possible reason for the poor agreement is the difficulty of expressing the diode characteristic in a simple form for the computations. A.

537.311.1

9460. Path-length problems of electrons in metals and semiconductors. V. E. Justi, M. Kohler and G. Lautz. *Abh. Braunschw. Wiss. Gesell.*, **3**, 34–43 (1951) *In German.*

The theory of K. Fuchs and R. B. Dingle is discussed in detail, and it is shown that there is a discrepancy between their formulae and the experimental results of van den Berg and hitherto unpublished own measurements for gold at liquid helium temperatures. On the assumption of Rutherford-scattering in a semiconductor the mechanism of electron scattering has only little influence in first approximation on the formulae derived by Fuchs for thin films. In agreement with similar observations on the anomalous skin-effect the authors propose to explain the discrepancy by the increase of residual resistivity with cold working of the surface layer and therefore by the enlargement of the effective surface-area. As to thin wires the assumption of a "surface-resistivity" yields some approximate results in good agreement with those of Dingle. In conclusion, the authors give a report of the above discussed resistivity measurements on cylindrical specimens of Mylius-gold. A.

537.311.1

9461. A note on resistance fluctuations and flicker effect. M. Surdin. *Physica*, **17**, 548–50 (*May*, 1951) *In French.*

The experimental results are reviewed and compared with those obtained theoretically. The flicker effect is explained by Macfarlane as due to fluctuation in the potential barrier and by Van der Ziel as due to fluctuations in the conductivity of the oxide layer. These points of view can be reconciled since both represent fluctuations in the number of free electrons, which was proposed by Bernamont to explain resistance fluctuations. The need for further experiment is stressed. A. H. W. Beck

537.311.1

9462. Attempt to interpret the electrical conduction mechanism in very thin metal laminations. N. Mostovetch. *C.R. Acad. Sci., Paris*, **233**, 360–2 (*July* 30, 1951) *In French.*

To explain the negative coefficient it is assumed that the metallic film is composed of very small grains (~ 100 Å). The work of an electron between two adjacent grains $<0{\cdot}1$ eV. Further, that the conductivity of the metal film is practically identical with that of the lacunae. It is found on mathematical grounds that the free electrons of a grain can follow the statistical distribution of Maxwell (semi-conductors) rather than that of Fermi (metal).

W. Summer

537.311.31

9463. Electrical properties of sodium tungsten bronze. E. J. Huibregtse, D. B. Barker and G. C. Danielson. *Phys. Rev.*, **84**, 142–4 (*Oct.* 1, 1951).

With the addition of Na atoms the ferroelectric insulator WO_3 acquires metallic properties. Single crystals of Na_xWO_3 have been grown; chemical analyses for Na concentration showed $x = 0{\cdot}66$. The electrical resistivity was found to have a value of $(1{\cdot}9 \pm 0{\cdot}2)\times10^{-4}$ ohm-cm at 0°c and to decrease approximately linearly with decreasing temperature in the range 20°c to −160°c. The Hall coefficient was found to have a value of $(-5{\cdot}1 \pm 0{\cdot}2)\times10^{-4}$ cm³/coulomb at 20°c and to decrease slightly with decreasing temperature. This value for the Hall coefficient indicates one electron carrier for each Na atom added to the crystal. Using Pauli's theory of

paramagnetism for free electrons in simple metals the calculated magnetic susceptibility is $0{\cdot}53\times10^{-6}$. The value observed by Stubbin and Mellor for a Na concentration corresponding to $x = 0{\cdot}9$ was $0{\cdot}45\times10^{-6}$. Using the free electron theory of metals, the following properties have been calculated: electron mobility and mean free path, energy at the surface of the Fermi distribution, thermal conductivity and electronic specific heat. A.

537.311.33

9464. On the ionic conductivity and lattice defects of silver bromide with monovalent impurities. J. Teltow. *Z. Phys. Chem.*, **195** (*No.* 3) 197–212 (1950) *In German.*

The electrical conductivity of silver bromide with additions of LiBr, NaBr, CuBr, AgCl, AgI has been measured in the mixed crystal region for various temperatures. In the case of CuBr the conductivity isotherms are strongly temperature-dependent and have a minimum. This is discussed.

P. T. LANDSBERG

537.311.33

9465. On the ionic and electronic conductivity and lattice defects of silver bromide with impurities of silver, cadmium and lead sulphide. J. Teltow. *Z. Phys. Chem.*, **195** (*No.* 3) 213–24 (1950) *In German.*

See preceding abstract. The equilibrium diagram and lattice constant of the system AgBr–Ag_2S have been investigated and the electronic contribution to the conductivity has been estimated. P. T. LANDSBERG

537.311.33

9466. Conductivity of organic salts. G. Manecke. *Z. Phys. Chem.*, **195** (*No.* 5–6) 354–61 (1950) *In German.*

The temperature dependence of the electrical conductivity of some organic salts of Na has been investigated. The log of the conductivity was found to be a linear function of the reciprocal temperature. The activation energy of the ions has been obtained.

P. T. LANDSBERG

537.311.33

9467. On the rectification of cuprous sulphide. T. Kushida and N. Inoue. *J. Sci. Hiroshima Univ.*, **15**, 71–7 (*March*, 1951).

Rectification was found to occur for contacts between pure Cu_2S and an Al, Mg or Zn electrode, each coated electrolytically with a thin layer of oxide film. With newly polished electrodes little rectification occurs. This is briefly discussed. P. T. LANDSBERG

537.311.33

9468. Electric properties of solid solutions of mercury-selenide and selenium. A. I. Blum and A. R. Regel. *J. Tech. Phys., USSR*, **21**, 316–27 (*March*, 1951) *In Russian.*

Electric conductivity of HgSe with small addition of Se was measured in the range of temperatures from −190°C to +850°C. The Hall effect and differential thermo-electromotive force were measured between −180 and +280°C. These measurements have shown the melting point of HgSe to be 690 ± 10°C. Limited solubility of selenium in hard HgSe was established. J. LUKASZEWICZ

537.311.33

9469. Electrical conductivity and lattice disorder of PbS. V. Genta. Letter in *Ric. Sci.*, **21**, 788–9 (*May*, 1951) *In Italian.*

The conductivity of PbS increases with temperature. An explanation of the phenomenon takes into account that this may be due to a lattice disorder in the sense that the PbS tends to absorb various quantities of S by producing anomalous crystals of the $PbS+PbS_2$ type, and that the conductivity is prevalently electronic. The conductivity increases with an increasing amount of S incorporated in the crystal, and is a function of the pressure of S. W. SUMMER

537.311.33

9470. Lead sulphide—an intrinsic semi-conductor. E. H. Putley and J. B. Arthur. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 616–18 (*July*, 1951).

Measurements of the Hall constant R and of electrical conductivity from 290 to 1100°K were made for specimens of galena of Sardinian origin, which although of high purity were not single crystals. The value of R above 650°K is substantially independent of the specimen on which it is measured and thus indicates intrinsic conduction in PbS and is the first evidence for this phenomenon based on the temperature variation of electrical properties. The forbidden gap width is found to be 1·2 eV in good agreement with Gibson's value [Abstr. 192 (1951)] for the lattice absorption edge. The variation in electrical properties in the intrinsic range is very similar to that of PbTe. C. A. HOGARTH

537.311.33

9471. Change of activation energy with impurity concentration in semiconductors. L. Pincherle. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 663–4 (*July*, 1951).

The activation energy may be considerably reduced by the screening of the field of the trapping centres produced by the free carriers. AUTHOR

537.311.33

9472. On rectifiers. W. C. van Geel. *Physica*, **17**, 761–76 (*Aug.*, 1951).

Experiments are described in which rectifiers were formed from combinations of metals, semiconductors and intermediate layers. The following combinations have been considered: (*a*) the contact between an excess semiconductor and a deficit semiconductor; (*b*) the combination aluminium|aluminium oxide| semiconductor; and (*c*) the combination metal|resin layer|semiconductor. In all these cases rectification occurs. The suggestion is put forward that, in all three cases, the contact between two layers with charge carriers of opposite sign is the cause of rectification. A.

537.311.33 : 621.314.63

9473. Effect of temperature on the height of potential barriers and on the breakdown voltage of contact rectifiers. E. Billig. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 752–3 (*Aug.*, 1951).

Considerations of the changes of energy gap with hydrostatic pressure in certain semiconductors suggest an experimental test of the Schottky diffusion theory.

Correlation between the change in energy gap and barrier height should be possible if measurements of the effect of large hydrostatic pressures on the characteristics of barrier layer rectifiers are carried out.

C. A. HOGARTH (R)

537.311.33

9474. On asymmetric heat conduction in copper–copper oxide rectifiers. F. H. HORN. Letter in *J. Appl. Phys.*, **22**, 1214 (*Sept.*, 1951).

Reinvestigation showed no trace of the asymmetry observed by Starr [*Physics*, **7**, 15–19 (*Jan.*, 1936)]. A reason for this discrepancy is suggested.

I. D. L. BALL

537.311.33

9475. Contribution to the theory of impurity centers in silicon. W. BALTENSPERGER. Letter in *Phys. Rev.*, **83**, 1055 (*Sept.* 1, 1951).

An electron moving in the field of an impurity ion (P in Si), the dipole field of the polarized atoms and the periodic field of the crystal has been considered. A hydrogen-like wave function was used and was minimized with respect to the radius a. The minimum of the total energy was found to occur at $a = 7$ Å in broad agreement with the results by Pearson and Bardeen [Abstr. 6199 (1949)]. P. T. LANDSBERG

537.311.33

9476. Carbon, oxygen, and sulfur content of Chilean coppers as related to cuprous-oxide rectifiers. C. C. HEIN AND W. M. HICKAM. *J. Appl. Phys.*, **22**, 1192–5 (*Sept.*, 1951).

Several Chilean coppers used in cuprous-oxide rectifier work have been analysed for C, O and S. The C determinations were in agreement with published solubility data. Large differences were found in the O and S content which could be correlated with the refining data of the Cu and the reverse leakage currents of the rectifiers. The changes in S content caused by various heat treatments were also investigated. A.

537.311.33

9477. The effects of pressure and temperature on the resistance of $p - n$ junctions in germanium. H. H. HALL, J. BARDEEN AND G. L. PEARSON. *Phys. Rev.*, **84**, 129–32 (*Oct.* 1, 1951).

According to Shockley's theory, the low voltage resistance, R_0, of a $p - n$ junction is proportional to $\exp(E_G/kT)$, where E_G is the energy gap. Measurements of the change with pressure of the characteristics of a junction in a single crystal of Ge indicate a change $\Delta R_0/R_0$ of 12·5%, corresponding to a change ΔE_G of about $3{\cdot}1\times10^{-3}$ eV, for a pressure change of 10 000 lb/in². Analysis of measurements made at temperatures between 16·5°C and 20·5°C give values of E_G averaging about 0·72 eV. These values are in agreement with those obtained from the change in intrinsic resistivity with temperature and pressure. A.

537.311.33 : 621.314.63 : 621.315.59

9478. Electrons and holes in semiconductors, with applications to transistor electronics. W. SHOCKLEY. *New York, Van Nostrand* (1950) 551 *pp.*

A comprehensive account of modern theory and practice in the semiconductor field with particular stress on Ge transistor characteristics and operation. Topics considered in the 17 chapters include: bulk properties of semiconductors; the transistor as a circuit element; injection of holes and electrons; physical theory of transistors; quantum theory of semiconductors; energy bands and Brillouin zones; velocities and mobilities in electric and magnetic fields; Hall effect; transistor electronics; statistical and quantum mechanics; and the theory of transition probabilities for holes and electrons. Adequate references are given, together with name and subject indices. G. F. J. GARLICK

537.311.6

9479. A possible explanation of the increase of the electrical resistance of thin metal films at low temperatures and small field strengths. C. J. GORTER. *Physica*, **17**, 777–80 (*Aug.*, 1951).

The film is supposed to consist of separate grains or blocks and the energy required for separation of a positive and a negative charge, located on different grains, is compared with the thermal energy kT. The resulting picture seems to describe in principle the observed increase of resistance. A.

537.312.5

9480. Phenomena in barrier-layer photo elements and a resulting theory of the barrier-layer photo- and rectifier-effect. P.-E. WEBER. *Optik*, **8**, 302–10 (*July*, 1951) *In German.*

This is a new theory, deviating from Schottky's assumptions. The barrier layer in a Cu–Cu_2O arrangement is explained as a layer of O atoms held by Cu atoms. Conductivity exists when an electron from the N shell of a free Cu atom which is embedded in the Cu_2O is freed by polarization or photo-ionization. When the freed electron is made to pass through the adjacent Cu layer a photoeffect has been achieved. If the electron is collected immediately the effect is one of rectification. Selenium cells of three manufacturers were used for the measurements, but the theory is explained in terms of Cu–Cu_2O cells.

W. SUMMER

537.312.5 : 535.215

9481. Spectral characteristic of Sb–Cs photocathodes in the ultra-violet down to 1 500 Å. V. SCHWETZOFF AND S. ROBIN. *C.R. Acad. Sci., Paris*, **233**, 475–8 (*Aug.* 6, 1951) *In French.*

A Sb–Cs vacuum photocell has been produced from pure materials without the use of an oxygen atmosphere. Maximum sensitivity occurs at 3 550 Å (contrary to a considerable number of different data) with a second (small) max. at 1 600 Å. The position and number of peak sensitivities is assumed to be a consequence of impurities in the layer material or, perhaps, is due to metallic compounds formed between the Sb and Cs. W. SUMMER

537.312.5 : 535.215

9482. Spectral characteristic of Sb–K and Sb–Na photocathodes in the ultra-violet down to 1500 Å. V. SCHWETZOFF AND S. ROBIN. *C.R. Acad. Sci., Paris*, **233**, 518–20 (*Aug.* 13, 1951) *In French.*

Highly purified materials were used under complete absence of O. Sensitivities (W filament at 2 550°K) are: 2·3 μA/lm (Sb–K), and less for the Sb–Na as

against 12 μA/lm for a Sb–Cs cell. Maxima occur at 3 400 Å (Sb–K) and 3 000 Å (Sb–Na). Long wave (red) thresholds are 5 500 Å (Sb–K) and 4 000 Å (Sb–Na). W. SUMMER

537.312.6

9483. The problem of electric resistance of one-phase monovalent metals. N. V. GRUM-GRZHIMAĬLO. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 461–2 (1951) *In Russian.*

L. Nordheim [*Ann. Phys., Leipzig*, **9**, 641 (1931)] is criticized for supporting his theory by test results on Au–Ag alloys. Results of investigation of Rb–K alloys were used to obtain coefficients of Mattisen's formula for variation of electric resistance with absolute temperature. Variation of these coefficients was found to be different from predictions based on Nordheim's theory. J. LUKASZEWICZ

537.312.62

9484. Superconductivity of Bi_2K. N. E. ALEKSEEVSKIĬ. *J. Exp. Theor. Phys., USSR*, **20**, 863–4 (*Sept.*, 1950) *In Russian.*

Bi_2K was found to become superconducting at 3·57°K and the value of dH_c/dT at T_c was 160 gauss/°K. D. SHOENBERG

537.312.62

9485. Eddy currents and supercurrents in rotating metal spheres at liquid helium temperatures. P. B. ALERS, J. W. MCWHIRTER AND C. F. SQUIRE. *Phys. Rev.*, **84**, 104–7 (*Oct.* 1, 1951).

These experiments show that large eddy currents are set up in a Sn sphere rotating at 4·6 or more r.p.s. in the earth's magnetic field and at 3·8°K. Within experimental determination, the eddy currents have the same magnitude and distribution on the sphere as the supercurrents which cause the Meissner effect at 3·7°K. These results are in accord with classical electromagnetic theory for a normal conductor and with the London theory for a superconductor. The Meissner effect has been produced in bulk Ta metal by rotating the specimen while cooling through the superconducting transition temperature. A.

537.312.62

9486. Some peculiarities of the transition into the superconducting state. I. A. A. GALKIN, YA. S. KAN AND B. G. LAZAREV. *J. Exp. Theor. Phys., USSR*, **20**, 865–70 (*Oct.*, 1950) *In Russian.*

The resistance of a Sn wire was recorded as the temperature was slowly (5×10^{-4} °K per min.) and smoothly lowered through the transition temperature and was found to show violent changes of an irregular character in the transition region (about 2×10^{-3}K wide). These irregularities disappeared if a sufficiently large longitudinal magnetic field was applied. The effects are ascribed to the complicated kinetics of growth of superconducting nuclei formed in the transition region. D. SHOENBERG

537.312.62

9487. Some peculiarities of the transition into the superconducting state. II. A. A. GALKIN, B. G. LAZAREV AND P. A. BEZUGLYI. *J. Exp. Theor. Phys. USSR*, **20**, 987–94 (*Nov.*, 1950) *In Russian.*

Three experiments are described: (1) Oscillograms were taken of the e.m.f. in a coil wound on a Sn rod in a longitudinal a.c. field large enough to destroy superconductivity; (2) the reduction of a persistent current in a superconducting Sn ring was studied after an a.c. field (frequency 10^2 to 10^4 c/s) of amplitude H_c had been applied round the ring. The reduction is only partial due to the skin effect; (3) the destruction and restoration of superconductivity in a Sn rod by an a.c. field superimposed on a steady field was studied in nearly adiabatic conditions. It is concluded that the boundary between normal and superconductive phases can move with a velocity of at least 10^3 cm/sec. D. SHOENBERG

537.312.62

9488. Destruction of superconductivity by an alternating current. A. A. GALKIN AND P. A. BEZUGLYI. *J. Exp. Theor. Phys., USSR*, **20**, 1145–6 (*Dec.*, 1950) *In Russian.*

In earlier experiments [Lazarev, Galkin and Khotkevitch, *J. Exp. Theor. Phys., USSR*, **11**, 573 (1941) *Dokl. Akad. Nauk, SSSR*, **55**, 817 (1947)] it was shown that if a d.c. current I_1 and an a.c. current of amplitude I_0 were superimposed in a Tl wire, the p.d. across the wire reached a maximum value V for $I_0 + I_1 = I_c$, the current just sufficient to destroy superconductivity; the value of V for given I_0 was found to fall off at frequencies of the order of 10^6 c/s. Recent experiments on Sn by Serin, Feldmeier and Garfunkel showed instead that V increased with frequency at fairly low frequencies. The authors suggest that this was due to the conditions becoming adiabatic rather than isothermal, and this was confirmed by showing that the effects observed by Serin *et al* could be reproduced if the Sn wire was in a glass envelope, but not if it was in direct contact with the liquid He bath. D. SHOENBERG

537.312.62

9489. On the phenomenological theory of superconductivity. H. KOPPE. *Z. Naturforsch.*, **6a**, 284–7 (*June*, 1951) *In German.*

The temperature dependence of the constant Λ in the London equations leads to a dependence of the entropy on the magnetic field. This makes Λ dependent on the current density and leads therefore to a non-linear generalization of the theory. [See also Pippard, Abstr. 8754 (1950)]. H. LONDON

537.312.62

9490. Investigation of superconductivity in lead compounds. R. P. HUDSON. *Proc. Phys. Soc., Lond. A*, **64**, 751–2 (*Aug.*, 1951).

Various specimens of PbS and PbTe investigated by the ballistic-throw magnetic method did not become superconductive down to 1·3 °K. In a few specimens a very small (partial volume) effect was found at the normal Pb transition temperature. In these, X-ray patterns indicated presence of excess Pb. H. LONDON

537.312.62

9491. Superconductivity of lead isotopes. M. OLSEN. Letter in *Nature, Lond.*, **168**, 245–6 (*Aug.* 11, 1951).

Difference in transition temperature T_c between samples of atomic weights M of 206·15 and 207·72 was $0\cdot038_6 \pm 0\cdot002$°K. This makes $T_c \propto M^{0\cdot73 \pm 0\cdot05}$. H. LONDON

537.312.62

9492. Theoretical aspects of superconductivity. Crystal structure and superconductivity. H. FRÖHLICH. *Nature, Lond.*, **168**, 280 (*Aug.* 18, 1951).

An optimum for the attainment of superconductivity is reached if the number of free electrons per atom is equal to 1/4. This requires either nearly empty or nearly full Brillouin zones, which is actually the case for most superconductors. R. B. DINGLE

537.312.62

9493. Theoretical aspects of superconductivity. Superconductivity and effective mass of electrons. H. FRÖHLICH. *Nature, Lond.*, **168**, 280–1 (*Aug.* 18, 1951).

A criticism of Bardeen's suggestion that a very small effective mass for electrons might alone lead to superconductivity. Unless explicit account is taken of the change of interaction between electrons and the vibrational field in the presence of a magnetic field, the normal state exists and has always the lower Gibbs free energy. R. B. DINGLE

537.312.62

9494. Theoretical aspects of superconductivity. Specific heat of metals at low temperatures. M. J. BUCKINGHAM. *Nature, Lond.*, **168**, 281–2 (*Aug.* 18, 1951).

The interaction between the lattice vibrations and the conduction electrons in a metal leads to modifications in the properties of the normal state at low temperatures. The theory accounts for the observed anomalous peaks in the specific heats of Na and Be, and gives about the right value for the energy content of the hump for Na. R. B. DINGLE

537.312.62

9495. An unbranched laminar model of the intermediate state of superconductors. C. G. KUPER. *Phil. Mag.*, **42**, 961–77 (*Sept.*, 1951).

The experiments of Meshkovsky and Shalnikov on the domain structure of a sphere in the intermediate state give no support to the "branching" model described by Landau. The present theory assumes an unbranched laminar structure, and does not involve any precise assumptions about the shape of superconducting regions near the surface of the specimen. Assuming only that demagnetizing coefficients for the superconducting domains can be defined, the Landau thermodynamical potential $L = F - (HB + hB - hH)/8\pi$ is found. By minimizing this function, the spacing and size of the superconducting domains can be calculated. The magnetization curve for ellipsoidal specimens is calculated, and is in moderate agreement with experiment. A.

537.312.9

9496. The variation of the resistivity of some metals with elastic deformation. M. J. DRUYVESTEYN. *Physica*, **17**, 748–60 (*Aug.*, 1951).

The variation of the resistivity with elastic deformation of Cu, Ag. Au, Al, Mo, W, Pt, and some alloys was measured on wires and on foils. In the case of Al single crystals were prepared and all three crystal constants of the tensor, giving the relation between the relative variation of the resistivity and the deformation, could be determined. In the case of Cu, Ag and Au foils with a preferred orientation were used. From the measurements on these foils the anisotropy of Cu, Ag and Au could not be determined; hence, it was not possible to calculate exactly the above mentioned constants for these metals. The product of the anisotropy and the degree of the texture of the foil was determined. A.

537.321 : 536.48

9497. The suppression of the thermoelectric effect at very low temperatures. M. KOHLER. *Abh. Braunschw. Wiss. Gesell.*, **3**, 49–54 (1951) *In German.*

The thermoelectric phenomena of electronic conductors are considered using only the 3 principal laws of thermodynamics. As a consequence of the Nernst theorem the product of electrical conductivity σ and differential thermoelectric force must vanish for $T \to 0$. Only if $\lim_{T \to 0} \sigma \neq 0$ must it be concluded that the thermoelectric force disappears in the limit $T \to 0$. If $\lim \sigma = 0$ (for instance for some semiconductors) the theorem of Nernst gives no essential rule for the behaviour of the differential thermoelectric force at $T = 0$. If the Thomson coefficient μ is given by $\mu = \beta.T^n$ in the neighbourhood of $T = 0$, the Nernst theorem gives for the case $\lim_{T \to 0} \sigma \neq 0$ the condition $n > 0$. The hitherto accepted condition was $n > 1$. Thus the present theory explains the higherto reported discrepancies between the thermodynamical and the electron theoretical treatment of the thermoelectric phenomena. A.

537.323

9498. The thermoelectric power of metal films. E. JUSTI, M. KOHLER AND G. LAUTZ. *Z. Naturforsch.*, **6a**, 456–9 (*Aug.*, 1951) *In German.*

The thermoelectric power of films of Bi relative to Cu was found to diminish with diminishing film thickness. At a thickness of 100 Å it was only about 14% of the normal value. The theory is discussed. P. M. DAVIDSON

537.363

9499. Conductivity measurements during the electrophoresis of proteins. Electrophoresis measurements by potentiometry. J. VERGNOLLE. *J. Chim. Phys.*, **48**, 295–302 (1951) *In French.*

The object of this and the two succeeding papers is the determination of conductivity at different levels of a vertical electrophoresis tube, in order to obtain the real mobilities of different ions separated by proteins, and to compare the diagrams obtained with similar ones afforded by optical methods. In the present paper a special apparatus is described for the determination of electrophoresis data by potentiometric measurements, and results are given for various serums. 10 references. H. H. HODGSON

537.363

9500. Conductivity measurements during the electrophoresis of proteins. Electrophoresis measurements by conductimetry. J. VERGNOLLE. *J. Chim. Phys.*, **48**, 303–17 (1951) *In French.*

Recent work by Lagercrantz [Abstr. 3014 (1945)] is discussed, and an apparatus is described in detail, with relevant theory, based on the work of

Lagercrantz, in which difficulties concerning temperature and observation are resolved for conductimetric measurements during electrophoresis.

H. H. HODGSON

537.363

9501. Conductivity measurements during the electrophoresis of proteins. Measurements of electrophoresis by conductimetry. Attempt to analyse data obtained from the distribution of current between electrodes of varied configurations. J. VERGNOLLE. *J. Chim. Phys.*, **48,** 318–32 (1951) *In French.*

A general scheme is derived for the mathematical analysis of current distribution data obtained during measurements of electrophoresis with electrodes of varied configuration and distance apart. The general formulae arrived at enable selectivity curves to be drawn for the interpretation of conductivity data measured under circumstances encountered in electrophoresis.

H. H. HODGSON

537.365

9502. Demonstration of the Debye effect at 80 kc/s in colloidal solutions of arsenic sulphide and in electrolytic solutions of potassium chloride. B. DÉROUET AND F. DENIZOT. *C.R. Acad. Sci., Paris,* **233,** 368–70 (*July* 30, 1951) *In French.*

Ultrasonic waves (80 kc/s) were produced by a 600 W magnetostriction generator. The p.d. due to the Debye effect (electrical polarization originating in colloidal or electrolytic solutions subjected to ultrasonic irradiation) were proportional to the concentration of the solution and to the amplitude of the speed of displacement. In experiments the latter quantity reached 3 cm/s, and the p.d. of 5 μV/cm/s was in accord with results of other investigators.

W. SUMMER

ELECTRIC DISCHARGES 537.52

537.523 : 537.312.5

9503. A note on the effect of the photo-electric emission from the electrodes on the rectifying action of a discharge. V. T. CHIPLONKAR. *Indian J. Phys.*, **25,** 138–40 (*March*, 1951).

This has been quantitatively investigated by using an improved dynamic method. The rectification is found to be affected to some extent by the onset of the emission, but the effect is found to be non-selective, it increases the current during one half of the cycle, leaving the current in the other half unaffected. A.

537.523.3

9504. Point-to-plane corona in dry air. H. W. BANDEL. *Phys. Rev.*, **84,** 92–9 (*Oct.* 1, 1951).

A survey study has been made of point-to-plane corona in dried air for a range of pressures and point sizes. It has been found that negative points can be satisfactorily triggered by ultraviolet illumination and that the difficulties encountered in past attempts have probably been due to too intense illumination and possibly the presence of dust on the points. Under some conditions transitions from Trichel pulses to a pulseless Townsend-type discharge have been observed for negative points at high voltage. With positive points the occurrence of pre-onset streamers has been found to depend on higher pressures and the presence of water vapour to give sufficiently high photon absorption. Breakdown streamers are not observed with standard geometry for the usual points sizes, because the first one always closes the gap resulting in breakdown. For points of around 2 mm. dia. the gap must be about twice standard length with room air, and about two and one-half times standard length with dried air, for breakdown streamers to be observed. A.

537.523.4

9505. Mechanism of positive spark discharges with long gaps in air at atmospheric pressure. H. NORINDER AND O. SALKA. *Ark. Fys.*, **3,** *Paper* 19, 347–86 (1951).

Deals mainly with the photographic observation of chopped impulse discharges (1/50 μsec impulse waveform) between spheres (1·44 to 50 cm dia.) or points (30° cones) and a plane electrode. The latter had negative polarity. Attention is directed towards long gaps (5–155 cm) with particular emphasis on the earlier stages of breakdown. Breakdown voltage characteristics for the gaps are given. The authors divide the spark process into 3 main parts: (1) a faintly luminous filamentary discharge with a short, thick, strongly luminous stem; (2) a more strongly luminous filamentary discharge, identified by the authors as a positive streamer, accompanied by a bushel-like discharge also filamentary in structure; and finally (3) the spark channel regime. The effect of overvoltage is not given in detail. It is concluded by the authors that neither Townsend nor streamer mechanisms account satisfactorily for all the stages of long discharges. J. D. CRAGGS

537.523.5

9506. On the light intensities of small type spectral lamps. II. On the influences of external circuits and weak magnetic field. H. TAKEYAMA, K. NISIMOTO AND T. MATUBAYASI. *J. Sci. Hiroshima Univ. Ser. A,* **15,** 57–66 (*March*, 1951).

For Pt I, see Abstr. 6242 (1951). The fluctuations in light intensities, terminal voltages and currents of certain hot cathode discharge lamps, which were previously studied, are affected by variations in various parameters, and the effect of altering the terminal voltage, parallel condenser, capacitance, etc., is described in the paper. The effects are complicated, but it is suggested that the fluctuations arise at the anode. J. D. CRAGGS

537.523.5 : 621.3.066.6 : 621.316.5.064.2

9507. Arcing at electrical contacts on closure. II. The initiation of an arc. L. H. GERMER. *J. Appl. Phys.*, **22,** 1133–9 (*Sept.*, 1951).

For Pt I, see Abstr. 6889 (1951). The capacity of the plates of an oscilloscope charged to 35 or 40 V is discharged repeatedly by approaching electrodes of carbon, active silver and inactive silver. Facts about the discharges, which are arcs of very short duration, are inferred from resulting open-circuit potentials and calculated electrode separations. The separation at the first arc varies in different experi-

ments but corresponds on the average to a nominal electric field of $0{\cdot}6\times10^6$ V/cm for carbon or active silver and to 2×10^6 V/cm for inactive silver. Each arc is initiated by a very small number of field emission electrons. The hypothesis that a single electron may perhaps be sufficient is consistent with observations at later stages of each closure when the electrodes are closer and the field much higher. The earlier observation, that the potential across a short arc is constant and independent of current, is not true if the arc time is sufficiently short. For active silver a time comparable with 2×10^{-6} sec is required to establish the steady arc voltage characteristic of later stages of arcs which last longer than this. The initial time during which the potential is decreasing toward its final steady value is $100\times$ the transit time of a silver ion across the gap. A.

537.523.5 : 621.315.618 : 621.3.015.5

9508. Observations on the electrical breakdown of gases at 2 800 Mc/s. W. A. Prowse and W. Jasinski. *Instn Elect. Engrs Monogr. No.* 10, 11 *pp.* (*Oct.*, 1951) [To be published also in *Proc. Instn Elect. Engrs, Pt IV*, **98** (1951)].

Electrical discharges at 2 800 Mc/s are produced in a nosed-in cavity type of resonator by energizing it from a pulsed magnetron. Individual pulses of various durations in the range 0·25–2·5 μsec are employed. Electrons are provided in mid-gap by the short u.v. radiation from an auxiliary d.c. spark actuated from the circuit used to trigger the power pulse. Descriptions and illustrations are given of the form of the resulting discharge, which in typical cases begins in mid-gap and advances towards the electrodes, crossing a 1 cm gap in times of the order of 1 μsec. The discharges in different gases at atmospheric pressure show wide differences in appearance. Oscillograms of the envelope of the field in the resonator show a very rapid collapse when the discharge occurs; in certain cases, notably hydrogen, a striking consistency of behaviour is exhibited. Studies of the absorption coefficient of the active radiation from the auxiliary gap agree with the supposition that it lies in the short u.v. region, and it is found possible to calculate the variation of sparking probability with distance of the irradiating spark from the resonator. Confirmatory experiments with pulsed d.c. sparks support the argument. A.

537.525 : 538.561

Plasma oscillations. *See Abstr.* 9610

537.525.8

9509. Production of Joshi effect in iodine vapour under X-rays. V. G. Bhide. Letter in *Curr. Sci.*, **20**, 178–9 (*July*, 1951).

A note describing positive and negative Joshi effects and offering an interpretation in terms of certain corona (space charge) phenomena. J. D. CRAGGS

537.525.8

9510. The theory of the pressure drop in a glow discharge subjected to a magnetic field. R. Danninger and H. Sirk. *S.B. Öst. Akad. Wiss., Abt. IIa*, **159** (*No.* 3–6) 59–62 (1950) *In German.*

A theoretical treatment of the pressure drop due to a transverse magnetic field acting on a glow discharge. The pressure drop is caused by the collisions between neutral and charged particles, the movements of the latter being affected by the field. J. D. CRAGGS

537.529 : 621.315.5.066.6

9511. Errata: The electric tunnel effect across thin insulator films in contacts. R. Holm. Letter in *J. Appl. Phys.*, **22**, 1217 (*Sept.*, 1951).

See Abstr. 5447 (1951).

X-RAYS 537.531

537.531 : 535.33

9512. New emissions in the X-ray spectra of tungsten and mercury. G. Barrère. *C.R. Acad. Sci., Paris*, **233**, 376–7 (*July* 30, 1951) *In French.*

A new satellite ($L\gamma_1'$) of $L\gamma_1$ has been observed in the L spectrum of W excited at 400 000 V, i.e. about $40\times$ the excitation potential necessary. Several K emission lines of Hg excited at 140 000 V have been measured, and the K level of Hg calculated. A.

537.531 : 535.34

9513. Contribution to the theory of the fundamental X-ray absorption edge of atoms in molecules. E. E. Vaĭnshteĭn, R. L. Barinskiĭ and K. I. Narbutt. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 6) 1003–6 (1951) *In Russian.*

The authors' theory [*Izv. Akad. Nauk, SSSR, Otdel. khim. nauk*, **71** (*No.* 1) (1945); *ibid.* (*No.* 4) 344 (1950); Abstr. 5022 (1950)] is further developed. It is claimed that the theory can solve quantitatively, unambiguously and completely the problem of the structure of the atomic X-ray absorption spectra for the monatomic inert gases or for polyatomic molecules in which the configuration of electron shells is analogous to that in inert gases. Theoretical curves for A agree well with experimental data. It has also been found that the ratios of intensities of the successive selective absorption lines in X-ray spectra are practically identical for all inert gases. F. LACHMAN

537.531 : 535.34

9514. Structure of the X-ray fundamental absorption edge of atoms in molecules. E. E. Vaĭnshteĭn, R. L. Barinskiĭ and K. I. Narbutt. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 1) 39–42 (1951) *In Russian.*

Recent experimental data obtained for HCl, HBr, H_2S, CS_2 and SO_2 are analysed in the light of the authors' theory (preceding Abstr.). The theoretical absorption curves display analogies with experimental curves. It has been calculated that, for the excited molecules $(HCl)^+$ and $(H_2S)^+$ formed in the bulk of the absorbing gas, the first ionization potential is of the order of 7 eV. For all gases studied, the values of the coefficient of the polarization of the molecule (α) as calculated from X-ray spectra are less by 30–50% than those obtained from refraction, but larger than values characteristic of a singly-charged ion of the element similar to the K-ionized molecule. F. LACHMAN

537.531 : 535.34

9515. Correlation between the theory of the fundamental X-ray absorption edge and the fine-structure theory. R. L. Barinskiĭ, K. I. Narbutt and E. E. Vaĭnshteĭn. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 1) 49–52 (1951) *In Russian.*

The classical (Kronig–Petersen–Bogdanovich) fine-structure explanation of the fluctuations of the coefficient of absorption is compared with the authors' theory (preceding Abstr.), according to which the structure of the fundamental X-ray K-edge of absorption of atoms and gaseous molecules can be fully decoded if it is looked upon as the result of a superposition of the continuous absorption (electron transsitions $1s \rightarrow \sim$) with the series of absorption lines (electron transitions $1s \rightarrow np$ in the molecule). It is claimed that the Kronig–Petersen–Bogdanovich theory is inapplicable to fluctuations of the coefficient of absorption on the long-wave side of the true absorption edge. F. LACHMAN

537.531 : 535.34

9516. Magnitude of the sudden change of the coefficient of X-ray absorption. E. E. Vaĭnshteĭn, R. L. Barinskiĭ and K. I. Narbutt. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 225–8 (1951) *In Russian.*

It is shown that the empirical relationship $S_k = E_K/E_L$ (S_k = the "jump," or the ratio of the absorption coefficients on the short-wave and long-wave side of the discontinuity, E_K and E_L = the energy of the K and L levels of the absorbing atom, respectively), advanced by Jonsson [Dissertation, Uppsala (1928)] has no theoretical foundation. The observed value of the "jump" $S'_k = \mu_3/\mu_1$ can often not refer to the true absorption edge, but only characterize the relative intensity of the first selective line of absorption, in accordance with the authors' theory (preceding Abstr.). It is possible to show that the true value of the "jump" for A is $\sim 5{\cdot}5$, while the observed value is $10{\cdot}4$. The absorption "jump," as construed by Jonsson, is not an atomic constant, since it depends upon n^* (effective main quantum number) and upon η (effective charge of the molecule residue after K-ionization). F. LACHMAN

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.72

9517. New information on the [paraxial] electron-optical properties of [homogeneous] magnetic [sector] prisms. R. F. K. Herzog. *Acta Phys. Austriaca*, **4** (*No.* 4) 431–44 (1951) *In German.*

A sector prism is treated as composed of a part bounded by edges $\perp$ to the principal ray and of, in general, 2 wedges. For the radial focusing these act as thin lenses (converging or diverging according to the sign of the angle of refraction) whose effect is added to that of the $\perp$ly bounded sector. The axial focusing action of the wedges is also calculated—it is claimed, for the first time [but see Kelman *et al*, *J. Exp. Theor. Phys., USSR*, **9**, 681–4 (1939); Ya. L. Khurgin, *ibid.*, **9**, 824 (1939)]. The axial focal length of a wedge = − (radial focal length). Some special cases of stigmatic focusing are considered and application to electron microscopy is suggested. Experiments to be described later have confirmed the occurrence of stigmatic focusing. J. C. E. JENNINGS

537.533.72

9518. Electron-optical properties of electrostatic systems with apertures deviating from an ideal shape. B. M. Rabin, A. M. Strashkevich and L. S. Khin. *J. Tech. Phys., USSR*, **21**, 438–44 (*April*, 1951) *In Russian.*

The apertures are elliptical and the potential field is found by an extension of the method of Strashkevich, *J. Tech. Phys., USSR*, **10**, 91 (1940), for various electrode arrangements. Two examples are tabulated and compared with measurements in an electrolytic tank. A series development valid near the axis is also obtained and the differential equations of the ray are set up. In the usual way, an integral expression is obtained for the longitudinal axial astigmatism, when the lens is thin and weak. J. C. E. JENNINGS

537.533.72

9519. A magnetic electron-optical system analogous to a plano-concave lens. I. I. Tsukkerman. Letter in *J. Tech. Phys., USSR*, **21**, 559–601 (*May*, 1951) *In Russian.*

Consideration of rays emitted non-skew from an object immersed in the field of an axially symmetric lens leads to the conclusion that they may be diverged on leaving the lens field. J. C. E. JENNINGS

537.533.72

9520. New formulae for the third order aberrations of [axially symmetric] magnetic lenses. P. Sturrock. *C.R. Acad. Sci., Paris*, **233**, 146–7 (*July* 9, 1951) *In French.*

Integral expressions, better suited to numerical computation than were those of Glaser and of Scherzer, are given for the aberration coefficients; the integrands are functions of the axial field and of 2 solutions of the paraxial ray equation. J. C. E. JENNINGS

537.533.72

9521. New formulae for the third order aberrations of [axially symmetric] electrostatic lenses. P. Sturrock. *C.R. Acad. Sci., Paris*, **233**, 243–5 (*July* 16, 1951) *In French.*

Analogous expressions are given to those of the preceding Abstr. J. C. E. JENNINGS

537.533.72

9522. On a new test method for spherical aberration of electron lenses. O. Klemperer. *Proc. Phys. Soc., Lond. B*, **64**, 790–4 (*Sept.*, 1951).

The focus of rays from a lens with spherical aberration appears as a spot surrounded by a discrete halo ring if a diaphragm with fine circular aperture is placed across the beam in front of the focus. The diameter of the halo allows an estimate of the magnitude of the aberration involved. The geometry of rays forming the halo is explained here by schematic drawings. The practical application of the halo test is illustrated by some examples. In particular, the

negative spherical aberration produced by an electronic space charge in a saddle field lens is demonstrated. A.

537.533.72

9523. Mathematical data for electron drain on positive ion sources. S. E. RAUCH. *J. Appl. Phys.*, **22**, 1128–32 (*Sept.*, 1951).

A study of the motion of electrons moving in the presence of crossed electric and magnetic fields is presented. Special electromagnetic regions are selected for discussion which assist in the controlling of electron discharge on positive ion sources when used with large mass-spectrograph units. The article compares the components of motion parallel and perpendicular to the magnetic field in the following regions: Uniform crossed electric and magnetic fields; electric field produced by non-parallel plane condenser plates, uniform H parallel to one plate; electric field produced by coaxial circular cylindrical condensers, uniform magnetic field normal to axis of cylinders; uniform electric field, circularly bowed magnetic field. The components of motion are expressed in terms of mathematical functions, and where it is deemed useful additional results are presented in graphical form so that the conclusions can be applied with a minimum of calculations. A.

537.533.72 : 539.165/.166

Spectroscopy of beta- and gamma-rays. *See Abstr.* 9668

537.533.72 : 621.385.83 : 621.317.729

9524. Factors affecting the design of an automatic electron-trajectory tracer. K. F. SANDER, C. W. OATLEY AND J. G. YATES. *Instn Elect. Engrs, Paper* 1175, 8 *pp.* [*Early Proof Issue*].

Describes a new method of determining electron trajectories in an electrostatic field. Information derived from a model electrode system in an electrolytic tank is passed automatically and continuously to a differential analyser, where the equations of motion of the electron are integrated and its trajectory is traced on an output table. Electric-field components in the tank are sampled by means of pairs of probes dipping into the electrolyte, and the voltage between the two probes of each pair is balanced automatically on a potentiometer and is thus converted into a shaft rotation which can be fed into the differential analyser. The output shafts from the differential analyser determine the mean position of the probes in such a way that it moves along the trajectory which is being plotted. Results obtained with apparatus based on these principles are described, and a detailed analysis of the factors affecting the overall accuracy is included. A.

537.533.72

9525. Automatic operation of a beta-ray spectrometer. W. C. KELLY AND K. J. METZGAR. *Rev. Sci. Instrum.*, **22**, 665–7 (*Sept.*, 1951).

Apparatus has been developed which permits the collection of data with a magnetic lens beta-ray spectrometer without requiring the attendance of the operator. The apparatus adjusts the focusing current and finds the time to accumulate a given number of counts. Forty-five sweep speeds are possible giving momentum intervals between plotted points ranging from 0·106 gauss cm to 255 gauss cm. A.

537.533.74

9526. Investigations on the elastic scattering of slow electrons in helium, neon and argon. S. WESTIN. *K. Norske Vidensk. Selsk. Skr., No.* 2, 136 *pp.* (1946).

The equations for the elastic scattering of electrons by an atom with paired electrons, taking all interactions into account, are formally identical with those for scattering by a static potential, and the results are expressible in terms of the phase shifts of the spherical harmonic components of the plane incident wave. Expts. on the scattering of slow electrons in He, Ne and A, and phase shift analysis of the results, give a good check on this general theory. An electrical device for obtaining the phase shifts from the angular distribution curves is described. A. O. STANESBY

537.533.74 : 778.3

9527. On the use of [track] gaps in nuclear emulsions sensitive to electrons. M. RENARDIER AND Y. AVIGNON. *C.R. Acad. Sci., Paris*, **233**, 393–5 (*July* 30, 1951) *In French.*

Accurate measurements of the gap lengths gave no better distinction between different particles than simple gap counting. J. J. WILKINS

537.533.74 : 778.3 : 519.24

Multiple scattering of ionizing particles in photographic emulsions. Statistics of the sampling distributions. *See Abstr.* 9231

537.533.75

9528. The range and straggling of high energy electrons. R. R. WILSON. *Phys. Rev.*, **84**, 100–3 (*Oct.* 1, 1951).

Simple expressions are derived for the range and straggling of individual electrons. Large energy losses due to bremsstrahlung make the average range smaller than would be calculated from the average energy loss. Effects of multiple scattering are included. The results are in good agreement with numerical calculations by the Monte Carlo method. A.

537.533.8 : 530.145

9529. Bremsstrahlung of particles having a magnetic moment as well as spin. N. N. KOLESNIKOV AND D. I. BLOKHINTSEV. *J. Exp. Theor. Phys., USSR*, **20** (*No.* 11) 979–86 (1950) *In Russian.*

An investigation of the relativistic case of electromagnetic radiation emitted under collision of a nucleus with such a particle. The emission is great if the extinction region reaches into the relativistic one, therefore particles with small mass and magnetic moment are most favourable. No energy transfer to the nucleus is considered. For nucleons and light nuclei the effect is reduced. J. JACOBS

537.533.8 : 537.591.15

9530. Further results on the fluctuation problem in electron-photon cascade shower theory and the probability distribution function. H. MESSEL. *Proc. Phys. Soc., Lond. A*, **64**, 807–13 (*Sept.*, 1951).

Results are presented both for the fluctuation and distribution of electrons in electron–photon cascade shower theory. The results were obtained in approximation A and are for the case of a single primary electron giving rise to the shower. A.

537.533.9 : 538.3

9531. Errata: Application of the radiation from fast electron beams. H. MOTZ. Letter in *J. Appl. Phys.*, **22**, 1217 (*Sept.*, 1951). See Abstr. 5470 (1951).

537.534

9532. Multiple traversal of cyclotron targets: an extension to the theory. J. M. CASSELS, J. M. DICKSON AND J. HOWLETT. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 719 (*July*, 1951).

Fourier transform techniques have been used to extend previous results [Abstr. 7946 (1951)] to the case of thin targets. J. HUGHES

537.534

9533. Multiple traversal of cyclotron targets. J. M. DICKSON. Letter in *Proc. Phys. Soc., Lond. B*, **64**, 615–16 (*July*, 1951).

Effective target thickness is plotted against actual target thickness for 150 MeV protons in the Harwell cyclotron, with results in agreement with the theory of Cassels, Dickson and Howlett [Abstr. 7946 (1951)]. T. G. PICKAVANCE

537.534 : 621.384.61

9534. Cyclotrons. T. G. PICKAVANCE. *Progress in Nuclear Physics*, 1. *London, Butterworth–Springer*; *New York, Academic Press* (1950) 1–20.

A review for non-specialists. The conventional cyclotron is briefly explained, but most of the article is devoted to the frequency-modulated cyclotron. Practical considerations of the following subjects are discussed: the magnet; magnetic pole design; the radio frequency system; the vacuum system; the ion source; extraction of the beam; shielding. The pulsed character of the extracted beam is described, and questions of instability and choice of modulation frequency discussed. The characteristics of several existing large f.m. cyclotrons are tabulated. There are 35 references.

537.534 : 621.384.62

9535. High voltage direct current generators for nuclear research. R. L. FORTESCUE. *Progress in Nuclear Physics*, 1. *London, Butterworth–Springer*; *New York, Academic Press* (1950) 21–36.

The principles of operation, range of voltage and current, and relative advantages of rectifier equipment and electrostatic generators, respectively, are briefly described. The characteristics of six representative generators are tabulated. The design and construction of the accelerating tubes are then discussed, followed by sources, and voltage control, measurement and stabilization. (Bibliography of 57 refs.)

537.534.74

9536. Some geometrical characteristics of classical Rutherford scattering. L. CASTOLDI. Letter in *Nuovo Cim.*, **8**, 491–3 (*July*, 1951) *In Italian.*

537.534.74

9537. Proton-proton scattering at 146 MeV. J. M. CASSELS, G. H. STAFFORD AND T. G. PICKAVANCE. Letter in *Nature, Lond.*, **168**, 468–9 (*Sept.* 15, 1951).

A constant differential cross-section for centre-of-mass angles 35° to 90° is reported, with magnitude $0{\cdot}0787 \pm 0{\cdot}0031$ of the $C^{12}(p,pn)C^{11}$ cross-section. J. J. WILKINS

537.534.75 : 778.3

9538. Comparative study of the Ilford G5 and C2 nuclear emulsions in the analysis of the $Be^9(d,p/t/\alpha)$ reactions. W. M. GIBSON, R. M. PAYNE AND J. CATALÁ DE ALEMANY. *An. Real. Soc. Esp. Fis y Quim.*, **47A**, 151–60 (*July–Aug.*, 1951) *In Spanish.*

Ilford G5 and C2 Nuclear Research emulsions were exposed under identical conditions to the reaction products from the bombardment of Be by analysed 300 keV deuterons. The range-energy relationship for these two emulsions were found to be alike for protons whose energy $< 4{\cdot}5$ MeV. A.

537.534.9

9539. On the light from synchrotron beams. H. OLSEN AND H. WERGELAND. *K. Norske Vidensk. Selsk. Forhandl.*, **23**, *Paper* 22, 91–5 (1950).

Convenient approximations are derived for the spectral distribution of e.m. radiation from an electron in a uniform circular orbit, in the limits of high and low frequency. In the intermediate region, a saddlepoint approximation to the exact expression is given, whence a formula due to Schwinger [Abstr. 2859 (1948)] is re-derived. R. H. DALITZ

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 537.534.74

9540. On the application of a Philips ionization gauge type of ion source in a mass spectrometer leak detector. N. WARMOLTZ. *Appl. Sci. Res.*, **B2** (*No.* 1) 61–5 (1951).

A leak detector using a P.I.G. source and perpendicular homogeneous electrostatic and magnetic fields would combine the advantages of high intensity, good resolution and freedom from filament replacement. T. G. PICKAVANCE

537.542

9541. An externally coated Pyrex G-M counter. M. YASIN, R. AHMED AND P. S. GILL. *Indian J. Phys.*, **25**, 182–6 (*April*, 1951).

This is reported as possessing a plateau of more than 1 600 V. Some other properties of this counter are also described, together with a tentative explanation of its characteristics. A.

537.542

9542. Factors affecting the stability of Geiger–Müller counters with thin end windows (bell counters with an argon-alcohol filling). A. PAPINEAU. *J. Phys. Radium*, **12**, 667–70 (*June*, 1951) *In French.*

In particular the effects of the proportion of alcohol in the counter filling, the diameter and composition of the sphere terminating the wire, and its distance from the metal window were studied. J. HUGHES

537.542

9543. On the directional effect of Geiger–Müller counters. A. ROGOZINSKI. *C.R. Acad. Sci., Paris*, **233**, 426–8 (*July* 30, 1951) *In French.*

This note gives suggestions for utilizing the different modes of pulse formation for primary particles

travelling along and normal to the counter wire in order to give directional variations in sensitivity. In the latter case (particle movement normal to the wire) the finite velocity of propagation of the Geiger discharge is operative. The suggestions are confirmed by expts. the results of which are quoted.

J. D. CRAGGS

537.542

9544. A toroidal Geiger counter. C. P. HAIGH. Letter in *Nature, Lond.*, **168**, 246–7 (*Aug.* 11, 1951).

Gives geometrical details and sensitivity, plateau slope, etc., for a toroidal γ-ray counter of mean diameter 12 in.

J. D. CRAGGS

537.542

9545. On the migration velocity of electrons in mixtures of argon and alcohol. A. A. QUARANTA, L. MEZZETTI, E. PANCINI AND G. STOPPINI. *Nuovo Cim.*, **8**, 618–43 (*Sept.*, 1951) *In Italian.*

A new experimental method for determining the transit time of the electrons in a G.M. counter is described. Use is made of the results obtained with various experimental arrangements for the study of the dependence of the drift velocity upon the electric field strength. For values of E greater than 200 V/cm, in a mixture of 90 mm Hg of A and 10 mm Hg of C_2H_5OH, the drift velocity turns out to be practically independent from the applied field, with a value of $(5{\cdot}2 \pm 0{\cdot}8) \times 10^6$ cm/s. This conclusion is compared with the results obtained by other authors, and discussed qualitatively in terms of the different types of collisions which the electron undergoes with the molecules of the gaseous mixture. Some results are also given on the best operating conditions of G.M. counters in experiments in which it is important to minimize the time lags due to the spread of the discharge along the central wire.

A.

537.542

9546. Effects of solution composition in a G.M. counter for liquid samples. G. ROSE AND E. W. EMERY. *Nucleonics*, **9**, 5–12 (*July*, 1951).

The counters used were thin glass wall (30 mg/cm^2) G.M. tubes, 6 cms long $\times$ 1·5 cm diameter, coated inside with graphite to form the cathode and surrounded by an outer jacket, leaving a 2 mm annular space to contain the active solution. The paper deals with the effect of solution density on the counter sensitivity. Active isotopes, P^{32}, Na^{24}, I^{131}, Br^{82} and Co^{60} were examined in aqueous H_3PO_4, $AgNO_3$, NaI and NaOH solutions of varying concentration and in organic solvents giving mass densities ranging from 0·8 to 1·8. In cases where the counts were mainly due to β-particles the logarithm of the sensitivity (for a given volumetric concentration of activity) was found to fall roughly linearly with increasing mass or electron density of the solution. The rate of fall was almost independent of the energy of the β-particles. In the case of Br^{92} where nearly all counts were due to γ-radiation, the sensitivity increased slightly with density in NaI solution and fell slightly in NaOH the difference in behaviour being attributed to photoelectrons ejected from the iodine.

L. R. SHEPHERD

537.542 : 621.387.424

9547. A circular Geiger-Mueller counter. G. ENSELL AND S. D. CHATTERJEE. Note in *Rev. Sci. Instrum.*, **22**, 700 (*Sept.*, 1951).

The construction and properties of toroidal counters, intended to increase the solid angle subtended by the counter at a source, is described.

J. HUGHES

537.542 : 621.387.424

9548. Construction of the external-cathode Geiger counter. M. L. MACKNIGHT AND R. L. CHASSON. Note in *Rev. Sci. Instrum.*, **22**, 700–1 (*Sept.*, 1951).

Practical details, and properties, are given for counters to be used in cosmic ray research.

J. HUGHES

537.542

9549. A portable ionization chamber with logarithmic response. M. BRIÈRE, A. ROGOZINSKI AND J. WEILL. Letter in *J. Phys. Radium*, **12**, 697–9 (*June*, 1951) *In French.*

Gives circuit details and response curves for ionization chambers having a logarithmic variation of sensitivity and which are therefore suitable for the measurement of widely varying intensities of radiation.

J. D. CRAGGS

537.542

9550. Scintillation counting. G. COWPER. *Nat. Res. Coun. Can., Publ., No.* 2394, 21 pp (1949).

A review of the properties and uses of scintillation counters.

A. O. STANESBY

537.542 : 535.376

Some considerations on the scintillation phenomena of organic crystals. *See Abstr.* 9393

537.542 : 616–073.75

9551. A scintillation counter for chemical use. D. KOHL, G. MOORE AND S. CHOU. *Nucleonics*, **9**, 68–73 (*July*, 1951).

Describes a scintillation counter employing an anthracene phosphor, used for localization of brain tumours with I^{131}. The counter has a good field-sensitivity pattern and is about nine times as efficient as G.M. counters previously used for the purpose.

L. R. SHEPHERD

537.542 : 621.317.71

9552. A combined current indicator and integrator. W. A. HIGINBOTHAM AND S. RANKOWITZ. *Rev. Sci. Instrum.*, **22**, 688–90 (*Sept.*, 1951).

Combines a current integrating circuit and a d.c. amplifier to provide a continuous indication of the current being integrated. It is stable, easy to calibrate and covers a range of input currents from 0·01 to 500 μA full scale.

A.

537.542 : 621.318.572

9553. A comprehensive counting system for nuclear physics research. N. F. MOODY, W. D. HOWELL, W. J. BATTELL AND R. H. TAPLIN. *Rev. Sci. Instrum.*, **22**, 442–61 (*July*, 1951).

II. Functional units. For Pt I, see Abstr. 7973 (1951). Complete circuit descriptions of the various sub-assemblies are given, together with a critical survey of the factors leading to the chosen designs. These sub-units are as follows: a decade scale,

resolving time 2·5 μsec; a high speed scale of 8, resolving time 0·25 μsec; a scaler input unit or "shaper"; a discriminator (general purpose); electromechanical register drive unit; high voltage supply unit; general purpose power unit supplying any four units selected from the above, except the fifth. Particular attention is paid to engineering and to the factors which lead to long life. In Pt I it was shown that a majority of instruments required for digital registration and pulse analysis in nuclear physics research could be based upon standardized sub-units. General design considerations and circuits of these sub-units are discussed here.

III. Automatic counting systems. Many advantages results when the counting involved in nuclear experiments is done automatically. An extensive system capable of carrying out a conditioned programme of counting and of printing the results is described. This system is built from basic functional units, and it is shown that this leads to great flexibility without undue complexity. Among the basic functions performed are the timing of a predetermined count and counting for a predetermined time. The operation may be conditioned by the programme of an automatic sample changer and also by the counting rate occurring. A special artifice is employed to enable a simple time interval printer to record the complex results from such a programme. A.

537.542 : 621.3.018.75 : 621.318.572

9554. A comprehensive counting system for nuclear physics research. N. F. Moody, W. J. Battell, W. D. Howell and R. H. Taplin. *Rev. Sci. Instrum.*, **22**, 551–63 (*Aug.*, 1951).

IV. Introduction to pulse amplitude analyzers. Gives an outline of pulse amplitude analysing equipment and indicates that for pulse widths of one microsecond and larger, as distinct from those in the millimicrosecond region, the thermionic diode leaves little to be desired as a voltage discriminating element.

V. The Chalk River pulse amplitude analyzer. Describes the pulse amplitude analysing designed and now in use at the National Research Laboratories, Chalk River, Canada. The key features include analysis at a 200-V pulse level, yielding a channel setting accuracy better than 0·1 volt or (1/2000 in terms of the maximum energy). The electronic resolving time is of the order of 10 microseconds, and pulses whose wave fronts range from ¼ to 1 000 volts per microsecond are accepted without pretreatment or the need for adjustment. Six analysing channels, based on the use of National Research Council's counting subunits, are contained in a cabinet and constitute a complete six-channel instrument. Interconnection of cabinets by four cables allows as many as 60 channels to be employed for a single analysis. Great attention has been given in the design to the operational aspects of reliability, stability and flexibility of application. A.

537.542 : 621.387 : 621.316.7.076.7

9555. Photoelectric control circuits for the ion source of a pressure-type electrostatic generator. L. O. Herwig. *Rev. Sci. Instrum.*, **22**, 668–72 (*Sept.*, 1951).

Control of the ion source located at the high potential is established from ground potential by means of a modulated light beam. An audio oscillator is used to modulate a light source and vibrating reed relays in the receiver are used as frequency selectors. A.

537.542 : 621.389 : 621.318.572

9556. Electronic circuits for nuclear detectors. G. G. Scarrott. *Progress in Nuclear Physics*, **1**, *London, Butterworth–Springer; New York, Academic Press* (1950) 73–114.

A comprehensive review of the various circuits associated with counting equipment and ionization chambers. The basic principles are discussed, and in many cases detailed design data are included. Section headings: Basic circuits; Negative feedback amplifiers; Actual feedback circuits; Trigger circuits; Use of diodes; Cathode coupled pairs; Delay lines; Amplifiers for ionization chambers and proportional counters; Detailed design of amplifier; Amplitude discriminators; Amplifiers for Geiger counters; Coincidence circuits; Gate circuits; Scalers; Pulse rate meters; Stabilizers.

537.542

9557. A large Wilson [cloud] chamber for research on cosmic radiation. A. Lovati, A. Mura, G. Tagliaferri and L. Terra. Note in *Nuovo Cim.*, **8**, 713–24 (*Sept.*, 1951).

For research on cosmic radiation a large Wilson cloud chamber has been built, suitable for containing several thick plates up to a total weight of some hundredweights. The instrument constructed is capable of rapid assembly and disassembly for repair, and change of plate layout; and together with its associated equipment, it occupies only a limited floor area. A.

537.542

9558. Diffusion cloud chambers. C. E. Nielsen, T. S. Needels and O. H. Weddle. *Rev. Sci. Instrum.*, **22**, 673–7 (*Sept.*, 1951).

Three forms of diffusion cloud chamber are described. Diagrams indicate their construction, and their operation is discussed. The direction of diffusion may be upward or downward. Various alcohols and water-alcohol mixtures may be used. A stable diffusion cloud chamber giving tracks of the quality shown in the typical photographs is simple to construct and operate. The sensitive volume, while necessarily in the form of a horizontal region shallower than the chamber itself, can be made to include most of the chamber volume. A.

IONIZATION . THERMIONICS 537.56/.58

537.561 : 537.534.72

9559. Measurement of ionization potentials with a mass spectrograph. G. Nief. *J. Chim. Phys.*, **48**, 333–5 (1951) *In French.*

Describes measurements of ionization potentials ("appearance potentials of positive ions") by Honig's method. Particular attention is paid to methane (CH_4^+) but data are also given for CO_2, C_6H_6,

$C_6H_5CH_3$, C_2H_6O, and NO (the primary ion in each case). It is claimed that the exptl. error is about 0·1–0·15 eV. J. D. CRAGGS

537.562

9560. The mechanism of positive ion collection by a spherical probe in a dense gas. R. L. F. BOYD. *Proc. Phys. Soc., Lond. B*, **64**, 795–804 (*Sept.*, 1951).

As the Langmuir probe technique is not suitable for measuring ion densities above 1 mm Hg pressure, a detailed examination is made of the possibility of using a probe collecting positive ions as a means of finding ion densities. It has been found possible to calculate the potential distribution, outside a space-charge sheath around a spherical probe, if the radius of the sheath is known. From this the current of positive ions to the probe may be found. Curves are given to facilitate this calculation. It is found that, depending on the ion concentration and pressure, there are two rather different sets of conditions around the probe. If the ion density is high (greater than about 10^8/mean free path in cm) a thin sheath will form on the probe and a complete solution of the problem is possible. Under such conditions the energies of the diffusing ions in the neighbourhood of the probe greatly exceed the thermal energies of the gas particles. At the lower ion densities normally encountered, a thick "diffusion" sheath occurs and the problem can now only be solved if the sheath thickness is known. The ion energies may or may not greatly exceed the thermal energies, depending on conditions. These results contradict one of the basic assumptions made by Davydov and Zmanovskaja in their approach to the same problem. A.

537.562 : 537.521

9561. Theory of ionized media with translational symmetry. M. HOYAUX. *Rev. Gén. Elect.*, **60**, 279–91 (*July*, 1951) *In French.*

Gives a general discussion of the simplified theory of plasmas. The general vector relations are set down, and include the fundamental equations for drift in a field, diffusion, current continuity, etc., and the major part of the paper deals with the kinetic theory of swarms, as applied to the calculation of mobilities, electron temperature and related quantities. J. D. CRAGGS

537.562 : 537.521

9562. The theory of ionized media with translational symmetry. M. HOYAUX. *Rev. Gén. Elect.*, **60**, 317–28 (*Aug.*, 1951) *In French.*

Continuation (preceding Abstr.). The general transport equations for a bipolar medium are given; expressions for instability (in the drift current) are also given with reference to the possibility of oscillations. The special case of cylindrical symmetry is then treated with special reference to the radial structure of low pressure plasmas. Finally, exptl. data are given and compared with the theory. J. D. CRAGGS

537.564 : 621.385.832.032.2

9563. Hollow cathode for positive ion studies in cathode-ray tubes. C. H. BACHMAN, H. EUBANK AND G. HALL. *J. Appl. Phys.*, **22**, 1208–10 (*Sept.*, 1951).

Apparatus has been designed and tested which makes possible the identification of the positive ions in the beam of a cathode-ray tube. A hollow cathode construction allows the positive ions to pass through the conventional part of the electron gun and be studied as a positive ion beam by another set of focusing electrodes and deflection magnets. Curves of ion yield and bucking potential measurements indicate that most of the ions are formed in the early stages of electron acceleration. A.

537.568

9564. Electron-capture cross sections for protons passing through hydrogen gas. F. L. RIBE. *Phys. Rev.*, **83**, 1217–25 (*Sept.* 15, 1951).

Measurements have been made of the electron-capture cross-sections σ_c in H gas for protons moving with kinetic energies between 34 and 149 keV. At these energy limits, σ_c has the values $1{\cdot}52\times10^{-16}$ and $2{\cdot}29\times10^{-18}$ cm^2, respectively. Using the values of the electron-loss cross-sections σ_l for H atoms in H gas recently measured in this laboratory, the ratio σ_l/σ_c was derived from the results of the present measurements. Direct measurements of this ratio agreed with the values derived from the separate measurements of σ_l and σ_c to within 10%. In the present case σ_l/σ_c is unity at an ion velocity of 1·44 Bohr units (e^2/h). This may be compared with the traversal of metals by protons, for which $\sigma_l/\sigma_c = 1$ is attained at 0·95 Bohr unit. A.

537.583

9565. On the poisoning of oxide-coated cathode due to adsorption of particles liberated from the anode. S. DEB. *Indian J. Phys.*, **25**, 197–215 (*April*, 1951).

The paper presents a theoretical treatment of the rate of decay of current due to adsorption of particles liberated from the anode of a valve using oxide-coated cathode. The cases of mobile and immobile adsorption are separately considered and graphical solutions for different conditions of the cathode surface and for different values of partial pressures of the poisoning agent are given. An approximate analytical solution of the problem is also given and this is found to predict a time constant of decay of current of about 10^{-3} sec under suitable conditions. It is shown that if the recently discovered phenomenon of pulsed emission decay in oxide-coated cathodes is to be ascribed to adsorption of gases liberated from the anode, it must be assumed that the adsorption is mobile with low energy of activation, the adsorbed particles in all probability being oxygen. On the basis of these assumptions attempt is made to explain the principal characteristics of the phenomenon. A number of experimental tests for the hypothesis is also suggested. A.

537.583 : 621.385.16.029.6 : 621.385.032.21

9566. Enhanced emission from magnetron cathodes. R. L. JEPSEN AND M. W. MULLER. *J. Appl. Phys.*, **22**, 1196–1207 (*Sept.*, 1951).

Existing theories of the static magnetron do not predict violation of the Hull cut-off condition or cathode bombardment. Measurements made at anode voltages and magnetic fields much larger than those used by earlier investigators revealed violations of the Hull cut-off condition considerably more pronounced than those previously reported, and much greater amounts of cathode bombardment. When

sufficient cathode bombardment takes place, emission may be enhanced (through secondary emission) by a factor of $\sim 10^3$ over the thermionic value. When enhanced emission occurs in magnetrons employing pure metal cathodes, it is found that maximum current limits exist for each magnetic field. These limits form a maximum current boundary on a voltage-current plot. The maximum current boundary depends on secondary emission properties of the cathode surface and on geometry. Experimental observations on enhanced emission, cathode bombardment, the maximum current boundary, and flow of anode current in violation of the Hull cut-off condition are combined into a self-consistent picture in static magnetrons employing pure metal cathodes. Although cathode bombardment and flow of anode current are still unexplained, their existence can account for the observed enhanced emission and maximum current boundary. In this it is unnecessary to endow the cathodes with anomalous thermionic or secondary emission properties. The process causing cathode bombardment, enhanced emission and flow of anode current in violation of the Hull cut-off condition is believed to be an electronic interaction which occurs almost entirely in the relatively dense region of space charge surrounding the cathode. The significant factors influencing the interaction appear to be applied electric and magnetic fields, space charge density and thickness of the space charge sheath. The basic problem of electronic interaction in the static magnetron is partially defined. It is expected that when a realistic solution to this problem exists, including a correct account of cathode bombardment, the occurrence of enhanced emission would be automatically predicted. A.

537.585

9567. The evaporation products of barium oxide from various base metals and of strontium oxide from platinum. L. T. ALDRICH. *J. Appl. Phys.*, **22**, 1168–74 (*Sept.*, 1951).

The evaporation products of BaO heated on ribbon filaments of Pt, Ta, Ni, Mo and W, and of SrO on Pt have been studied using a high resolution mass spectrometer for positive ion analyses. The ratio Ba^+/BaO^+ was measured for each base material as a function of temperature and of the energy of the ionizing electrons to determine the origin of each ion peak observed. The results indicate: (*a*) Only on systems BaO on Pt and BaO on Ni, and SrO on Pt were the evaporation processes reproducible without particular attention to procedure. (*b*) The two systems BaO on Pt and SrO on Pt differ markedly in their evaporation mechanisms. (*c*) At high temperatures peaks are found due to Ba_2O^{++}, Ba_2O^+, $Ba_2O_2^+$ and other barium compounds depending on the base metals used. (*d*) A measurable ion current was found due to Sr^+ ions evaporated from Pt. A.

COSMIC RAYS 537.591

537.591.08 : 539.172 : 539.16.08 : 778.3

Photographic emulsion technique. *See Abstr.* 9896

537.591.1

9568. On the masses of cosmic ray particles. S. AZIMOV, N. BIRGER, N. DOBROTIN, G. ZHDANOV, YU. KOKURIN AND S. SLAVATINSKIĬ. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 447–50 (1951) *In Russian.*

Reports results of two experiments. In the first, two cloud chambers were expanded simultaneously at 3 250 m. In the upper chamber, the momentum of particles was measured using magnetic fields up to 9 200 gauss, and in the lower, range was determined by observing stopping in one of 11 Pb plates each 0·8 cm thick. For the second expt., the lower chamber was replaced by 5 groups of hodoscoped counters alternating with Pb plates 0·7 cm thick. The errors are critically discussed. 90% of measured particles are found to fall into P or π- and μ-meson groups. The remaining 10% can be accounted for by spurious functioning of apparatus, in complete contrast to conclusions of Alikhanian *et al.*

E. P. GEORGE

537.591.1 : 539.172

Nuclear disintegrations induced by μ-mesons. *See Abstr.* 9685

537.591.15

9569. Contribution to the study of penetrating showers. H. A. MEYER, G. SCHWACHHEIM AND A. WATAGHIN. *An. Acad. Brazil Cienc.*, **23**, 61–72 (1951) *In Portuguese.*

From a study of the absorption in Pb of the particles of atmospheric and local showers it is concluded that the absorption cross-section of charged π-mesons in Pb is less than half the geometrical cross-section.

L. PINCHERLE

537.591.15

9570. On the second maximum of the Rossi transition curve. T. KAMEDA AND I. MIURA. *J. Sci. Res. Inst., Tokyo*, **45**, 65–76 (*July*, 1951).

The second maxima are conspicuously recognized near 15 cm Pb in the shower containing more than three particles as well as those containing more than two particles, especially in narrow angle showers. The agents of the second maxima are N-components. Whether the second maxima are found or not depends on the geometry of the arrangement. In the shower particles near the second maxima, penetrating particles are contained. The third maximum seems to exist near 25 cm Pb. A.

537.591.15

9571. On the constitution of the extensive showers of cosmic rays. C. MILONE. *Nuovo Cim.*, **8**, 643–50 (*Sept.*, 1951) *In Italian.*

The lateral structure of extensive cosmic-ray air showers is studied at Catania (elevation 35 m o.s.l.) by means of G.M. counters by selecting showers with average density of $\simeq 25$ particles/m^2 in the vicinity of the cores of the showers. The ratio $R_p/R_e =$ density of the penetrating particles at a distance r from the core of the shower/density of the total component at a distance r from the core of the shower, is found to increase slowly with r. It is excluded that this increase is due to the experimental disposition of the counters. A.

537.591.15 : 537.533.8

The fluctuation problem in electron-photon cascade shower theory and the probability distribution function. *See Abstr.* 9530

537.591.3

9572. The penetration of particles associated with cosmic-ray stars. II. J. A. NORTHROP. *Phys. Rev.*, **84**, 83–9 (*Oct.* 1, 1951).

For Pt I, see Abstr. 8847 (1950). A second series of measurements has been made at Climax, Colorado (elevation 3 510 m), of the particles associated with nuclear explosions, or stars, in a thin-walled ionization chamber. The associated particles were detected by observing coincidences between the ion chamber and appropriately placed trays of Geiger counters. The experiment was planned in such a way as to distinguish between those particles which are products of nuclear disintegrations which emerge from the ion chamber and those particles which are incident in the atmosphere in association with the particles producing the stars. Absorption measurements were made of both the low energy and penetrating product particles. There was no conclusive evidence indicating the presence of electrons or photons among the disintegration products. The absorption mean free path in Pb was not exponential but increased to 190 ± 40 g/cm^2 at the maximum of 8 in of Pb. Absorption measurements of the associated particles which are not disintegration products of the stars indicate that they are parts of local penetrating showers having mean free paths greater than 500 g/cm^2. Absorber placed over the ion chamber produced bursts of electrons in the chamber whose number greatly exceeded that of extensive air showers. These bursts have been tentatively identified with narrow air showers. A.

537.591.5

9573. The relation between cosmic-ray intensities and heights of isobar levels. I. M. WADA. *J. Sci. Res. Inst., Tokyo*, **45**, 77–86 (*July*, 1951).

The multiple correlations among the cosmic-ray intensities, the atmospheric pressure and the heights of isobar levels are calculated. For the heights of isobar levels, those of 100, 200, 300, 500, 700 and 850 mbs measured from 1 000 mb level are used. The coefficient of the barometer effect obtained is $-0{\cdot}23\%$/mm Hg, and the coefficient of the decay effect is $-6{\cdot}6\%$/km for 300 mb level. 86% of the variation of the cosmic-ray intensities can be explained by these two factors. A.

537.591.5

9574. Latitude effect of the distribution of mesons in the atmosphere. P. CALDIROLA, R. FIESCHI AND P. GULMANELLI. Letter in *Nuovo Cim.*, **8**, 508–11 (*July*, 1951) *In Italian.*

Assuming substantially single production of mesons, the meson spectrum and the charge ratio of mesons as a function of momentum are calculated for different values of geomagnetic cut-off of primary particles from a threshold value 3 BeV/c up to the latitude sensitive limit, about 15 BeV/c. J. G. WILSON

537.591.5

9575. Diurnal variation of dense extensive showers at 3 500 m altitude. C. BALLARIO, R. BRUNELLI, A. DE MARCO AND G. MARTELLI. Letter in *Nuovo Cim.*, **8**, 587–9 (*Aug.*, 1951) *In Italian.*

Two coupled unshielded counter arrays gave records of different particle densities in extensive showers. A possible solar diurnal variation of the densest recorded showers is discussed in terms of the total absence at certain times of showers of density greater than a determined limit. J. G. WILSON

537.591.8

9576. Transition effects for heavily ionizing particles and stars recorded by nuclear emulsions in the stratosphere. ZH. S. TAKIBAEV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 457–9 (1951) *In Russian.*

A stack of plates and Pb absorbers was flown at 25 km for eight hours. In plates under 1·8 cm Pb, the frequency of single tracks was 6 times and of stars twice that in unscreened plates. E. P. GEORGE

537.591.8

9577. Evaporation stars produced in metal foils. R. L. SETTI AND M. MERLIN. Letter in *Nuovo Cim.*, **8**, 504–7 (*July*, 1951) *In Italian.*

The absolute rate and size distribution of evaporation stars from thin foils of Al, Cu and Au sandwiched between emulsion was studied at 4 550 m altitude. J. G. WILSON

537.591.8

9578. Measurements of the star-producing radiation with a scintillation counter. E. G. MICHAELIS AND E. P. GEORGE. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 662 (*July* 1951).

Light pulses from a $1{\cdot}5$ cm^3 KI crystal were recorded with a photomultiplier, set to register energy releases >38 MeV. The absorption under Pb and the absolute frequency of events at sea level is consistent with their interpretation as "stars" occurring in the crystal. E. P. GEORGE

537.591.8

9579. The angular distribution of V^0-particle decay products. W. B. FRETTER. Letter in *Phys. Rev.*, **83**, 1053 (*Sept.* 1, 1951).

26 V^0-events observed in a cloud chamber at sea level were analysed under the assumption $V^0 \rightarrow p + \pi^-$. The angular distribution in the centre of mass system was very asymmetrical. Possible reasons are that some decays are $V^0 \rightarrow \pi^+ + \pi^-$, or that 3 decay particles are involved, e.g. $V^0 \rightarrow p + \mu + \nu$.

E. P. GEORGE

537.591.8

9580. The cascade production of cosmic ray stars and the relative number of charged and uncharged particles. G. THOMSON AND P. E. HODGSON. *Phil. Mag.*, **42**, 978–89 (*Sept.*, 1951).

A calculation has been made of the consequences of assuming that stars are produced in a cascade process by charged and uncharged particles according to a very simple law. The constants in this law can be chosen to give agreement with experiment to the extent to which the quantities are known and also fall within the ranges that are *a priori* permissible. It does not appear possible to determine them with much accuracy from existing data, but it seems that a fair proportion of the stars with less than five prongs are due to primaries of fairly high energy. A.

537.591.8

9581. Absorption length and collision length of hard-shower-producing radiation. D. POMEROY. *Phys. Rev.*, **84**, 77–83 (*Oct.* 1, 1951).

By combining techniques of coincidence counter circuits and nuclear photographic emulsions, values are obtained for the absorption length in air of 104 ± 6 (p.e.) g/cm^2, and for the collision length in paraffin of 61 ± 6 (p.e.) g/cm^2 for hard-shower-producing radiation. The method also provides evidence of a cascade mechanism by which the hard showers are produced. A.

537.591.8 : 539.172

9582. High energy event in nuclear emulsions at 4 550 m. A. GEROSA AND R. L. SETTI. Letter in *Nuovo Cim.*, **8**, 601 (*Aug.*, 1951).

An emulsion star obtained at 4 550 m with a singly charged primary leads to a relativistic shower with two well-defined forward cones of particles of angle respectively 0·004 and 0·1 radian. The energy of the event is estimated as 10^{13} eV, exceptionally great at this low altitude. J. G. WILSON

537.591.8 : 539.172

9583. The disintegration of light nuclei by cosmic rays. P. E. HODGSON. Letter in *Phil. Mag.*, **42**, 955–7 (*Aug.*, 1951).

The mean charge emitted in cosmic-ray stars in pure gelatine was determined using a sandwich emulsion in which pure gelatine and G5 emulsion alternated, exposed at 3 500 m. The average emission is less than the average charge of the constituents of gelatine by $(0{\cdot}87 \pm 0{\cdot}25)e$. This charge must reside, on grounds of range, on fragments of charge $> 2e$. One such fragment was observed. J. G. WILSON

MAGNETISM 538

538.082.74

9584. Axially symmetric systems for generating and measuring magnetic fields. I. M. W. GARRETT. *J. Appl. Phys.*, **22**, 1091–1107 (*Sept.*, 1951).

This is Part I of a systematic discussion of axially symmetric magnetic fields, both central and remote from the origin, search coils reporting the field or gradient at a single point, and mutual inductances. Here the central uniformity of symmetrical fields and gradients is analysed by zonal harmonic expansion. Laplace's equation and symmetry restrict these fields to a few types, regardless of the detailed geometry of the generating system. Universal error-contour maps are derived for the central field or gradient in systems having errors of 2nd, 4th or 6th order, and for hybrid types combining 2nd and 4th. One hybrid has an oblate error field suitable for cloud-chamber and orbital applications. Source systems include circular filaments, cylindrical or plane circular current sheets, and thick solenoids of rectangular or notched section. Each type of source may be designed to produce any of the field patterns. To this end, source constants derived for the particular source type are combined into a set of over-all coefficients that express the field constants for a complete system. Rapid methods are given for computing the source constants and from them all the field derivatives, using recurrent relations or tables of Legendre functions. In particular, computing time for thick-solenoid fields or gradients is greatly reduced, using a new series with a recurrence formula. The text includes tabular aids and reference formulas, and discusses the rate of convergence of series for central and remote fields, and for mutual inductances. Special systems briefly described include several infinite series of systems like that which starts with Ampere's loop, the Helmholtz pair, and Maxwell's 3-loop system. These have integral numbers of circular filaments from 2 to infinity. More practical are the thin solenoids. Those that produce a 4th-order (Helmholtz) field by omission of central turns are fully tabulated for all lengths. A short solenoid with double-wound ends and 6th-order error may realize greater uniformity in actual practice than any previously described system. Still greater (theoretical) uniformity is achieved in 2 8th-order combinations of a short solenoid with a loop pair; these are described and depicted, with error limits. A.

538.082.74

9585. A device for determining the direction of flux lines in the time varying magnetic field of a particle accelerator. R. E. RICHARDSON AND D. C. SEWELL. Note in *Rev. Sci. Instrum.*, **22**, 697 (*Sept.*, 1951).

A small coil is balanced with its axis horizontal. The plane in which the induced voltage is zero and the magnetic lines of force vertical can be found to $\frac{1}{16}$ in when the radius of curvature of the flux lines is 19 ft. J. H. FREMLIN

538.082.74 : 621.317.42

9586. Inductive method for investigating the topography of the field on the axis of a strong magnetic lens. C. FERT AND P. GAUTIER. *C.R. Acad. Sci., Paris*, **233**, 148–50 (*July* 9, 1951) *In French.*

A long solenoid is mounted coaxially with the lens and oscillated longitudinally, e.g. by a loud-speaker diaphragm. The first harmonic of the induced voltage is a measure of the induction B at the end in the field, the other end being in field-free space. An example of the instrument is described. The second harmonic from such a solenoid, or the first harmonic from a short search coil, would be a measure of the gradient B'. J. C. E. JENNINGS

538.11

9587. Limits on the energy of the antiferromagnetic ground state. P. W. ANDERSON. Letter in *Phys. Rev.*, **83**, 1260 (*Sept.* 15, 1951).

Shows that the bounds on the energy of the ground state are $-\frac{1}{2}NJZS^2 > E_0 > -\frac{1}{2}NJZS^2(1 + 1/ZS)$, where N is the number of atoms, J the exchange energy, Z the co-ordination number and S the spin quantum number. E. P. WOHLFARTH

538.11

9588. Dipolar broadening in antiferromagnetic substances. N. TSUYA AND Y. ICHIKAWA. Letter in *Phys. Rev.*, **83**, 1065 (*Sept.* 1, 1951).

Experimental results by Okamura *et al.* [Abstr. 5564 (1951)] are discussed theoretically. The temperature variation of the half-line widths is calculated for different lattice types and calculated values found to

be slightly smaller than observed, due, possibly, to the neglect of anisotropy energy effects.

E. P. WOHLFARTH

538.114

9589. An analytical approach to the Ising problem. E. W. MONTROLL AND T. H. BERLIN. *Commun. Pure Appl. Math.*, **4**, 23–30 (*June*, 1951).

The three-dimensional Ising problem is reformulated by using a representation of the Dirac delta function. A general integral formula for the partition function is given, the integrands involving certain determinants which are deduced. The new formulation is used to give an explicit solution of the one-dimensional problem. E. P. WOHLFARTH

538.114

9590. On the theory of free electron ferromagnetism. A. B. LIDIARD. *Proc. Phys. Soc., Lond. A*, **64**, 814–25 (*Sept.*, 1951).

A calculation has been made of the ferromagnetic properties of a system of electrons using plane wave functions and Bloch exchange integrals. Our results show that below a critical temperature T_c the spontaneous magnetization decreases slowly with increasing temperature. At T_c the magnetization drops suddenly to zero as if a change of phase were taking place and there is therefore a latent heat of demagnetization at this temperature. Above T_c the model is paramagnetic. The reasons for the differences between the results and those obtained by experiment and on Stoner's theory of collective electron ferromagnetism are discussed, and the possibility that they may be due to the neglect of positional correlations among the electrons is considered. A.

538.221

9591. Magnetic materials and ferromagnetism. A. E. DE BARR. *Research, Lond.*, **4**, 366–71 (*Aug.*, 1951].

A review of recent developments in magnetic materials with particular reference to the physical phenomena responsible. Grain orientation, domain orientation and the properties of single domain particles are considered, together with the properties of the commercial materials which have been produced. A. E. DE BARR

538.221

9592. Dependence of the effect of thermomagnetic treatment on the initial characteristics of a ferromagnetic. A. A. LUKSHIN AND YA. S. SHUR. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 243–4 (1951) *In Russian.*

It is shown that the effect of thermomagnetic treatment depends on the initial characteristics of the ferromagnetic material. The materials investigated were 66-permalloy (66% Ni, 34% Fe) and alsifer (5·5% Al, 9·5% Si, 85% Fe), of which the first was subjected to vacuum-anneal at 850° for 30 min and, alternatively, to anneal in a H-atmosphere at 1 200° for 5 hr with subsequent 1-hr vacuum-anneal at 900°C (the second method resulting in an improved crystal lattice and purification of the material). Method 1 resulted in increasing μ_0 by 28%, μ_{max} by 85%, method 2 in increasing μ_0 by 66% and μ_{max} by 550%. The alsifer specimens were only subjected to 2 hr vacuum anneal at 900°C and the percentage improvements, though much smaller, depended markedly on the initial values of the magnetic characteristics, i.e. were the better, the better the initial values. B. F. KRAUS

538.221

9593. Ferromagnetic properties of partially oxidized Fe and Fe–Co powders. F. LIHL. *Acta Phys. Austriaca*, **4** (*No.* 4) 360–79 (1951) *In German.*

The coercive force, remanence and maximum energy product of small magnets pressed from powder have been measured. The powders were formed by reduction of iron formate or mixed crystals of iron–cobalt formate, and the maximum values of coercive force and $(BH)_{max}$ were obtained when the reduction was not complete. The maximum coercive force was obtained with a shorter reduction time than the maximum energy product. Both coercive force and $(BH)_{max}$ were increased with increased Co content up to 27% Co (the highest percentage investigated). The results are compared with theoretical results on the magnetic properties of fine particles. A. E. DE BARR

538.221

9594. On the origin of magnetism in iron sulphides with various sulfur contents. T. HIRONE AND N. TSUYA. Letter in *Phys. Rev.*, **83**, 1063 (*Sept.* 1, 1951).

Theoretical considerations as to the lattice structure of FeS_x, e.g. formation of two interpenetrating sublattices, allow their ferrimagnetic and antiferromagnetic behaviour to be understood.

E. P. WOHLFARTH

538.221

9595. Reversible effects in the magnetization of nickel. R. S. TEBBLE, W. D. CORNER AND J. E. WOOD. *Proc. Phys. Soc., Lond. B*, **64**, 753–60 (*Sept.*, 1951).

An account is given of investigations on the temperature dependence of the contribution from reversible processes [see Abstr. 1938 (1951)] to the magnetization of annealed and strained Ni wires. This involves the measurement of reversible susceptibility κ_r over a range of field, and of temperature (−50°C to +200°C), and a rapid automatic method of recording (κ_r, H) curves has been developed. The effect of temperature on κ_r is discussed in relation to Becker's strain theory and reasons for the discrepancies are suggested. It is shown that the contribution of reversible processes to the total change in magnetization, integrated over the hysteresis cycle, increases with temperature and strain, from 15% for an annealed specimen at −50°C to 85% for a strained specimen (17·1 kg mm^{-2}) at 150°C. The effect is not uniform over the whole cycle and in the region of the coercive field a considerable part of the change in magnetization must be attributed to irreversible processes. A.

538.221 : 539.26

9596. Structure transition and antiferromagnetism in magnetite. N. C. TOMBS AND H. P. ROOKSBY. Note in *Acta Cryst.*, **4**, 474–5 (*Sept.*, 1951).

Reports X-ray investigations of the crystal structure of magnetite between R.T. and 95°K. A structure

transition was found to take place at low temperatures, it is believed in the neighbourhood of the magnetic transition temperature (125°K). E. P. WOHLFARTH

538.221 : 539.26 : 548.736.3

9597. Changes in lattice constants of Cr_2O_3 near the Curie temperature. S. GREENWALD. Letter in *Nature, Lond.*, **168**, 379 (*Sept.* 1, 1951).

Additional information on a structure change previously reported [see Abstr. 492 (1951)]. Below 320°K the rhombohedral angle increases as the temperature is lowered, giving rise to a separation of 422 and 652 reflections. A. E. DE BARR

538.222

9598. Paramagnetism of copper sulphate solutions. P. BERTHIER, C. COURTY AND J. GAUTHIER. *C.R. Acad. Sci., Paris*, **233**, 473–5 (*Aug.* 6, 1951) *In French.*

Susceptibility measurements on dilute aqueous solutions of $CuSO_4$ (0·25–18·11% by weight) at R.T. are reported and the results analysed. E. P. WOHLFARTH

538.222

9599. Paramagnetic resonance in some chrome alums at various temperatures. A. F. KIP, C. F. DAVIS, L. JENNINGS, D. REINER AND R. MALVANO. *Nuovo Cim.*, **8**, 683–92 (*Sept.*, 1951) *In Italian.*

It has been observed that the splitting of the ground state is almost temperature independent down to 4°K for the C.A. with rubidium and cesium, while it is strongly dependent for the C.A. with ammonium and potassium. Below a certain temperature the experimental evidence is explained assuming a definite variation of the microcrystalline symmetry of the electric fields around the chrome ions; in particular a rotation of the axis of the trigonal fields. A.

538.222

9600. Inter-ionic distances and line widths in paramagnetic resonance absorption. H. KUMAGAI, K. ÔNO, I. HAYASHI, H. ABE, J. SHIMADA, H. SHÔNO AND H. IBAMATO. Letter in *Phys. Rev.*, **83**, 1077 (*Sept.* 1, 1951).

Half widths in the more dilute Cu and Mn sulphate hydrates agree with those to be expected from dipolar coupling, but at smaller interionic distances exchange narrowing occurs. D. H. WHIFFEN

538.222 : 536.48

9601. Magnetic properties of metals at low temperatures. I. Periodic variation of magnetic susceptibility of single crystals of Cd, Be, Mg, Sn and In with magnetic field strength. B. I. VERKIN, B. G. LAZAREV AND N. S. RUDENKO. *J. Exp. Theor. Phys., USSR*, **20**, 995–1010 (*Nov.*, 1950) *In Russian.*

The de Haas–van Alphen effect (periodic field variation of susceptibility χ) has been found in Cd, Be, Mg, Sn and In and for each metal curves are shown of the field variation of $\Delta\chi$ for a given field direction, and of the variation of $\Delta\chi$ with field direction for a given field strength. The results are discussed qualitatively. [See also Abstr. 1071 (1950), 1176, 6326 (1951)]. D. SHOENBERG

538.222 : 536.48

9602. Investigation of nuclear effects in paramagnetic single crystals at very low temperatures. S. F. MALAKER. *Phys. Rev.*, **84**, 133–41 (*Oct.* 1, 1951).

The hyperfine structure coupling of the magnetic moment of the nucleus with the magnetic moment of the electronic cloud of a paramagnetic ion gives rise to a Schottky specific heat anomaly at an appropriate temperature. For the cobaltous ion in a single crystal of cobalt ammonium sulphate this temperature is about 0·1°K. In the region where the specific heat goes as A/T^2 and where the Curie law $\chi = C/T$ holds, one can make measurements of A by means of an a.c. mutual inductance bridge which measures the susceptibility of the paramagnetic salt. The method of measurement consists in superposing a d.c. magnetic field on the salt already in the a.c. field of the bridge. This d.c. field depresses the susceptibility an amount depending on the parameter C/A which is therefore a constant of the material being investigated. If one knows the Curie constant, then one has A immediately. This measured A, however, is made up of two contributions: (*a*) that arising from the nuclear-electronic coupling and (*b*) that arising from the dipole interaction of neighbouring paramagnetic ions. The (*b*) contribution is a function of concentration of the ions, so that by making measurements of A at various dilutions and plotting A as a function of dilution, one obtains an intercept by extrapolation to infinite dilution which is the part of A due to nuclear specific heat. The thermodynamic measurements made thus give a nuclear specific heat of $C_vT^2 = 16{\cdot}1\times10^{-4}R$, where R is the gas constant, which is in excellent agreement with $C_vT^2 = 16\times10^{-4}R$ calculated from microwave data. It is observed that pure cobalt ammonium sulphate has a Curie point at $\sim 0{\cdot}125$°K, while the diluted salts do not possess one in the same temperature region. A.

538.222 : 536.631

9603. Thermal and magnetic properties of caesium titanium alum. R. J. BENZIE AND A. H. COOKE. *Proc. Roy. Soc. A*, **209**, 269–78 (*Oct.* 23, 1951).

The magnetic susceptibility of a powdered specimen was measured between 4·2 and 1·0°K. The susceptibility obeyed Curie's law, with a Curie constant 0·118 per mole, corresponding to a Landé factor $g = 1{\cdot}12$. Measurements of spin-lattice relaxation effects between 1·3 and 0·9°K gave a relaxation time varying as $T^{-7\cdot5}$. An approximate measurement of the specific heat at 0·9°K gave $C_1T^2/R = 3{\cdot}9\times10^{-5}$. Interaction effects between the ions account for 90% of the specific heat, the remainder being attributable to the nuclear specific heat of the odd isotopes of Ti. The results are discussed in terms of the influence of the crystalline electric field on the energy levels of the magnetic ions. A.

538.222 : 539.152.1

9604. A new method of measuring weak frequency shifts in nuclear paramagnetic resonance. R. GABILLARD AND M. SOUTIF. *C.R. Acad. Sci., Paris*, **233**, 480–2 (*Aug.* 6, 1951) *In French.*

The proton resonance frequency in water solutions and immiscible paraffin in one sample holder give rise to a beat frequency which is accurately measurable

and after correction the shift of resonance between the two materials is obtained. D. H. WHIFFEN

538.222 : 539.152.2

9605. Quadrupole moments of copper 63 and 65. B. BLEANEY, K. D. BOWERS AND D. J. E. INGRAM. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 758–9 (*July*, 1951).

A brief review of the experimental results relating to the effects of electric quadrupole interaction on the paramagnetic resonance spectrum of copper Tutton salts. Experimental values for the various constants appearing in the Hamiltonian are given [Abstr. 5576 (1951)]. E. P. WOHLFARTH

538.23

9606. On ferromagnetic states. J. GILTAY. *Appl. Sci. Res.*, **B2** (*No.* 3) 199–216 (1951).

English translation of the article reported in Abstr. 1187 (1951).

538.27

9607. On the temperature dependence of magnetic viscosity of ferromagnetic metals. E. F. KURITSYNA. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 233–6 (1951) *In Russian.*

According to Telesnin [Abstr. 3643 (1951)] $\tau = A\chi_d/T$, where τ = relaxation time for the establishment of a new magnetic state of a ferromagnetic, χ_d = differential of magnetic susceptibility = dI/dH, T = absolute temp., and A = coeff. of magnetic viscosity. The relation between magnetic viscosity and temp. was studied from 86 to 1 013°K for iron and from 86 to 1 073°C for cobalt. Curves are given relating magnetization, hysteresis loops, relaxation time, curves of magnetic viscosity χ_d and A for temps. of 80, 293, 473, 673, 873 and 1 013°K. Curves are also given of max. magnetic viscosity and χ_d respectively against temp. It is concluded that Telesnin's equation is satisfied only at low temp. At high temps. only the order of A remains const. W. HUGHES

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 53.081

9608. The rationalization problem in electrodynamics. U. STILLE. *Abh. Braunschw. Wiss. Gesell.*, **3**, 122–34 (1951) *In German.*

The different methods for rationalization in electrodynamics are characterized in two general ways: (1) According to the principle of the method (variation of magnitudes or units) and (2) according to the unit which remains invariant against rationalization. The four most important methods of rationalization (rationalization of Heaviside–Lorentz, rationalization of Giorgi, and the modifications of those two methods regarding variation of magnitudes or units) are explained by simple examples, their consequences are confronted, and some general conclusions are drawn. If the rational and the non-rational treatment of electrodynamics are maintained in parallel in future the method of Giorgi thus represents the most suitable solution. A.

538.3 : 550.381

The generation of magnetism by fluid motion. *See Abstr.* 9842

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.561

9609. Demonstration of phase shift using voltmeters. F. MILLER, JR. *Amer. J. Phys.*, **19**, 366–7 (*Sept.*, 1951).

Demonstration of phase shift, attenuated waves, and some properties of oscillators is made with the aid of direct current voltmeters connected to various points in a one-valve phase shift oscillator circuit. Values of circuit components are given for a simple, stable oscillator with a period of the order of 10 to 15 sec. A.

538.561 : 537.525

9610. Plasma oscillations. G. WEHNER. *Overseas Res. Rep.* 235/51 [*Dep. Sci. Industr. Res., Lond.*]; *Off. Tech. Serv. Wash., PB* 110356.

Covers an investigation of electron plasma oscillations excited by a beam of fast electrons in a stabilized, l.p. Hg discharge. Probe measurements reveal that the r.f. oscillation fields are localized in thin layers, the plasma density and frequency of which follow Langmuir's law. The beam of fast electrons traversing such an oscillation layer becomes velocity-modulated and excitation conditions result from drift time and bunching considerations. A sealed-off, all-metal tube described covers a frequency range between 800 and 4 000 Mc/s (5 modes) without changing or matching any resonance circuit. Calculation of these oscillation modes agrees with the experimental results. It is concluded that testing of sealed-off tubes, especially to gain data about output, bandwidth noise and stability, together with further investigations concerning attenuation of the oscillation layers, beams produced by other than grid methods, and the best way for coupling-out of the v.f. energy, would be of value. A.

538.561 : 537.533 : 621.3.018

9611. Theory of the oscillations of interacting electron currents. YU. K. BERGNER. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 3) 435–8 (1951) *In Russian.*

The problem investigated is the propagation of waves along interacting electron currents moving at different mean velocities and also having velocities of thermal movement corresponding to various values of the parameters of the problem. The fundamental equations of the oscillating electron are assumed in the form given by Vlasov [*J. Exp. Theor. Phys., USSR*, **8**, 291 (1938)] and subjected to a Laplace transform with respect to the x-co-ordinate. The solving function is found as the analytical continuation of a function $I(z)$ determined only for $I_m z > 0$, and is a whole function. Only two approximations are necessary for considering the thermal movement of the electrons. The dispersion equation $\Delta(\gamma) = 0$ is solved next, the characteristic equation of which is of the 4th order. The amplitude and frequency relations of the waves are found from this equation for the approximation, excluding thermal movement, and the

conditions of maxima are discussed, and the maxima then found. The approximation excluding thermal movement may only be used in the absence of strong fluctuations. B. F. KRAUS

538.563 : 621.317.733

9612. A self-tracking bridge detector for audio-frequency bridges. J. L. UPHAM, JR. *Rev. Sci. Instrum.*, **22**, 659–64 (*Sept.*, 1951).

A tuned bridge detector with a constant band width of 5 c/s is described. The centre of this band is clamped electrically to the output frequency of the associated signal generator and deviates less than $\frac{1}{2}$ c/s from it. This makes manual tuning of the detector unnecessary. The narrow pass band of the amplifier reduces the noise signal to a very low value and allows detection of a $\frac{1}{2}$ μV signal across a 1 megohm input for a continuous range of frequencies from 100 c/s to 20 kc/s. The indicated noise level is of the order of $\frac{1}{2}$ μV for the 1 megohm input; this is about the theoretical thermal noise value (0·41 μV for 5 c/s, 1 megohm). The final detector signal can be easily used to activate mechanical drives for the two bridge controls in order to maintain balance of the bridge when the measured impedance changes or to reset to balance from an unbalanced condition. A.

538.566

9613. Extension of Weyl's integral for harmonic spherical waves to arbitrary wave shapes. H. PORITSKY. *Commun. Pure Appl. Math.*, **4**, 33–42 (*June*, 1951).

The generalized integral takes the form $F(ct-R)/R = -1/2\pi Re\{\int F_1'[ct-(\alpha x+\beta y+\gamma z)]d\omega\}$ where the diverging spherical wave is represented in terms of plane waves whose wave shape is given by the derivative of the real function F. F is related to the complex function F_1 by the relation $F(\xi) = Re\{F_1(\xi)\}$, where F_1 is analytic in a particular half plane and $F_1(i\infty) = 0$. The domain of integration is in general the same as that of Weyl's original integral, but has to be modified in the case of a current pulse. G. D. SIMS

538.566

9614. Vector wave functions. R. D. SPENCE AND C. P. WELLS. *Commun. Pure Appl. Math.*, **4**, 95–104 (*June*, 1951).

A review of the problem of finding solenoidal solutions of the vector wave equation, particularly in spheroidal co-ordinates. Various difficulties encountered when dealing with spheroidal systems are pointed out. L. PINCHERLE

538.566 : 534.21

The correlation function in the analysis of directive wave propagation. *See Abstr.* 9343

538.566 : 534.26 : 535.42

Diffraction and reflections of pulses by wedges and corners. *See Abstr.* 9400

538.566 : 778.3 : 534.231

A photographic method for displaying sound wave and microwave space patterns. *See Abstr.* 9352

538.566 : 621.392.26

9615. The offset wave-guide junction as a reactive element. L. D. SMULLIN AND W. G. GLASS. *J. Appl. Phys.*, **22**, 1124–7 (*Sept.*, 1951).

A new type of waveguide circuit element has been described that has a number of desirable electrical and mechanical properties. These include ease and accuracy of adjustment, and simple analytical expressions for some of the more important properties. The capacitive junction allows the practical construction of capacitively coupled resonant cavities. Such cavities have a relatively constant band width over their tuning range, as compared with the more commonly used inductively coupled cavities. A.

538.566 : 534.232

9616. Kirchhoff's formula, its vector analogue, and other field equivalence theorems. S. A. SCHELKUNOFF. *Commun. Pure Appl. Math.*, **4**, 43–59 (*June*, 1951).

The theoretical difficulties involved in the solution of diffraction problems are reviewed with reference to the problem of radiation from a horn (acoustic or electromagnetic). Several approximate formulae suggested by the Huygens principle are discussed in detail, and also possible methods of obtaining higher order approximations from the induction theorem. L. PINCHERLE

538.566 : 621.396.671

9617. Theory of V-antennas. R. KING. *J. Appl. Phys.*, **22**, 1111–21 (*Sept.*, 1951).

An integral equation for the current in an apex-driven symmetrical V-aerial is derived and solved by successive approximations. General formulae for the distribution of current and the impedance are obtained. The zero-order impedance is evaluated for a leg-length $h = \lambda_0/4$ as a function of the enclosed angle and used to estimate experimental results. A.

538.566 : 621.396.677

9618. Radiation properties of spherical antennas as a function of the location of the driving force. P. R. KARR. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 422–36 (*May*, 1951).

A theoretical analysis is made of the radiation properties of a perfectly conducting sphere excited as an aerial by a driving force that acts in the θ direction in a narrow strip around the circle of colatitude $\theta = \theta_0$ on the surface of the sphere. As the location θ_0 is varied, the radiation pattern, together with the current distribution and the input admittance, change. Unless θ_0 equals 90°, the radiation pattern is not symmetrical with respect to the equatorial plane. The radiation conductance, which is proportional to the amount of power radiated for a given applied voltage, varies in a complicated way with θ_0. However, for a sphere whose radius is not too large compared with the wavelength, this trend is approximately as $\sin^4\theta_0$. In some cases the radiation conductance is not a maximum for $\theta_0 = 90°$, but is greater when the feeding strip is somewhat to one side of the equatorial plane. Other features of the radiation are analysed. Reasons are given for believing that the idealization of the feed conditions does not prevent the theory from giving experimentally pertinent results for the radiation properties. A.

538.566.2

9619. The W.K.B. approximation as the first term of a geometric-optical series. H. BREMMER. *Commun. Pure Appl. Math.*, **4**, 105–15 (*June*, 1951).

The equation $(d^2y/dx^2) + k^2(x)y = 0$ representing the propagation of a plane wave perpendicular to

the stratifications of a medium whose refractive index is a function of x only, can be solved completely in terms of a series, the first of whose terms corresponds to the W.K.B. approximation. The succeeding terms may each be interpreted as arising from a discrete number of partial reflections within the medium. The solution can be split into an upgoing and a downgoing wave each of which satisfies a Volterra integral equation. The development of either wave in terms of series similar to the above merely corresponds to the Neumann–Liouville expansion of the solution of this equation by means of iterated kernels.

G. D. SIMS

538.566.2

9620. Remarks concerning wave propagation in stratified media. S. A. SCHELKUNOFF. *Commun. Pure Appl. Math.*, **4**, 117–28 (*June*, 1951).

When the incident wave is in an inhomogenious medium, the total wave cannot, in general, be decomposed into progressive components and this leads to a restriction of the conditions under which the reflection coefficient, as usually defined, is valid. An example illustrates the dangers inherent in the application of the results of idealized problems, to the determination of the reflection coefficient of a finite inhomogeneous layer. The fundamental wave equations are of the form $du/dx = -if(x)v$, $dv/dx = -ig(x)u$ where, if $f(x)$ or $g(x)$ are not analytic, u and v, representing electric and magnetic field, are continuous. By a change of variable it is shown that the only case in which no reflections occur is that for which $f(x)/g(x)$ is constant. Expressions are obtained for the first-order reflection coefficient, in the cases of both weak and strong reflections and the differential equation it satisfies is derived.

G. D. SIMS

538.566.3

9621. The diffraction of radio waves in passing through a phase-changing ionosphere. A. HEWISH. *Proc. Roy. Soc. A*, **209**, 81–96 (*Oct.* 8, 1951).

The radiowaves from "radio stars" may suffer irregular phase changes in passing through the terrestrial ionosphere, so that when they reach the earth's surface they produce a disturbance in which both amplitude and phase vary over the ground. In this paper it is assumed that the wave emerges from the ionosphere with amplitude constant but with phase varying across its wave-front, and deductions are made about the diffraction pattern produced at the ground. It is shown how, from a knowledge of the way in which phase and amplitude vary at the ground, it is possible to deduce the average magnitude of the phase deviations produced by the ionosphere and their lateral extent. It is also shown how an investigation of the diffraction patterns produced by different wavelengths may lead to an estimate of the distance of the effective diffracting screen from the plane of observation. Experiments to determine the diffraction pattern formed at the ground by waves emitted from a radio star are described in outline, and an application of the theory to some of the observations indicates that the ionospheric irregularities have a lateral extent of the order of 5 km and are sufficient to cause a phase deviation of 1 to 2 radians for a wavelength of 6·7 m. A.

538.566.3

9622. The theory of magneto-ionic triple splitting. O. E. H. RYDBECK. *Commun. Pure Appl. Math.*, **4**, 129–60 (*June*, 1951).

A comprehensive analysis of the problem showing that with respect to the "*O*" and "*Z*" waves (the "ordinary" and the "third" magneto-ionic components) the layers of the ionosphere act as if they constituted coupled transmission lines. The experimental observations of the *Z* trace at Kiruna observatory are briefly considered. W. J. G. BEYNON

538.569.2.047 : 537.226.2 : 615.84

Dielectric behaviour of human tissues at microwave frequencies. *See Abstr.* 9878–9

MAGNETIC EFFECTS 538.6

538.632 : 539.153

9623. Hall effect and electron configuration in the noble metals. E. JUSTI AND M. KOHLER. *Abh. Braunschw. Wiss. Gesell.*, **3**, 44–8 (1951) *In German.*

In some previously published papers the present authors have reported new precise measurements of the hitherto unknown Hall coefficients of Nb (Cb), Re, Ru, Rh, Ir and new values for Cu, Ag, Au. These coefficients show a monotonic change from high positive to high negative values with increasing atomic number in each period of the periodic system. These results can be explained satisfactorily in terms of a two band-model according to Mott. The quantitative evaluation of the measured values by the authors' formulae gives some results for the different configuration of electrons in the free and the crystalline state of these metals. The abnormally high positive A_H-values of Re and Ru can be explained by the assumption, that even holes in the upper band act as defect-electrons. A.

538.652

9624. The magnetostriction of single crystals of iron–silicon alloys. W. J. CARR, JR AND R. SMOLUCHOWSKI. *Phys. Rev.*, **83**, 1236–43 (*Sept.* 15, 1951).

The spontaneous magnetostriction of iron–silicon alloys can be adequately described by two constants h_1 and h_2. For ordered alloys h_1 goes through zero at about 11 atomic per cent silicon, h_2 at about 9 atomic percent silicon. In disordered alloys, in the composition range around 10 per cent silicon, h_1 is somewhat larger than for the ordered alloys. A method is given for calculating accurately the constants from the experimental data. The form effect is calculated and a semi-empirical theory is given of the influence of silicon on magnetostriction. A.

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

9625. Some problems of the electron theory of crystals. A. I. ANSELM. *J. Tech. Phys., USSR*, **21**, 489–503 (*April*, 1951) *In Russian.*

Intended to initiate a discussion. Attention is

drawn to weaknesses in the foundations, as distinct from the results, of the Bloch–Brillouin band theory of electric conduction in solids. (i) It is a one-electron approximation and, according to Pekar, the Bloch solution is, at least for metals, not even the correct solution of the Hartree–Fock equation. Treating the electron gas as a whole, however, leads to great difficulties; some Russian attempts are discussed. (ii) In polar crystals the electron-lattice interaction leads to the concept of polarons (Pekar), of which the effective mass, radius and mobility have been calculated. According to Pekar's strong interaction approximation, polaron properties differ greatly from those of electrons, whilst Fröhlich's weak interaction approximation leads substantially to the old electron theory; it is not clear to what conditions each applies. (iii) There are several ways of showing that the periodic potential of the lattice can often be replaced by a constant potential, if the mass of the electron is replaced by an effective mass. It is not clear, however, how far the stringent conditions attached to these derivations are or must be satisfied, or how far the results are valid. The method does not lead to the states of pairs of electrons (doublons) found by Bonch–Bruevich on an interaction theory. (iv) In semiconductors localized states are important and are usually investigated by the method of effective mass. The validity of this is dubious and it is in this approximation difficult to see how these states give rise to non-radiative transitions. J. C. E. JENNINGS

539.11 : 535.34

9626. The absorption of light by alkali metals. P. N. BUTCHER. *Proc. Phys. Soc., Lond. A*, **64**, 765–72 (*Sept.*, 1951).

The theory of the absorption of light by photo-excitation of the valency electrons in cubic metals is developed. The matrix elements vanish when calculated with respect to the Wigner–Seitz approximate wave functions for the occupied states in the first band, and free electron wave functions for the states in the higher bands. Calculations of the contribution to the absorbing powers of the alkali metals due to photo-excitation are made, using the approximation of nearly free electrons to obtain all the unperturbed wave functions. The calculated values for Na, K and Rb agree quite well with those observed if the first non-vanishing Fourier coefficient of the self-consistent potential field has the values 0·323, 0·305 and 0·350 eV respectively. A.

MOLECULAR STRUCTURE 539.13

539.13 : 541.57

9627. Comparison of isostere structures such as CO_2 and NO_2^+. A. POTIER. *J. Chim. Phys.*, **48**, 285–95 (1951) *In French.*

A comparison of the fundamental properties such as bond order, electron density, bond energy, of molecules of A–B–A type. All are expressed in terms of the true difference in electronegativity between A and B, based on molecular orbital method of a linear combination of atomic orbitals. Linear structure for CO_2, NO_2^+, N_3^-, CS_2 is deduced; AlO_2^-, BO_2^-, SiO_2 must be angular. J. JACOBS

539.132

9628. Quantum mechanical calculation of the polarizability of the hydrogen molecule. H. HARTMANN AND F. BECKER. *Z. Phys. Chem.*, **195**, 186–96 (1950) *In German.*

Following Gans and Mrowka [*Schr. Königsberg gelehrt. Ges., Naturw. Kl.*, **12**, 15 (1935)], the required molecular wavefunctions are obtained from the atomic wavefunctions which are used in the theory of the Stark effect, since these take into account the effect of the applied electric field on the atoms. In development of these calculations, an arbitrary constant is introduced and identified by application of a variational principle. P. T. LANDSBERG

539.132

9629. Empirical equations for calculating dissociation energies of C–H and C–C bonds in saturated hydrocarbon molecules and in free aliphatic radicals. V. V. VOEVODSKIĬ. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 3) 455–8 (1951) *In Russian.*

A comparison of dissociation energies and structure suggests that breaking the C–C bond of a paraffin radical, requiring 10–20 Kcal/mol, can occur like a homogeneous 1st-order reaction. The process of removal of an H, requiring 40–45 Kcal/mol, could take place at the walls of the container. J. JACOBS

539.132

9630. Calculation of the oscillator strength for the $^2\Pi$–$^2\Delta$ transition in the CH molecule. G. STEPHENSON. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 666–7 (*July*, 1951).

The *f*-value computed by the one-electron approximation is 0·008. Dunham's assumed value of 0·06 is probably too high. D. L. EDWARDS

539.132

9631. Transition probabilities in band-systems of diatomic molecules: A modified "distortion" process for the wave functions. M. E. PILLOW. *Proc. Phys. Soc., Lond. A*, **64**, 772–80 (*Sept.*, 1951).

A method previously used for "distorting" the wave functions of a simple harmonic oscillator to fit the potential curve for a particular electronic state has been modified, giving wave functions for the vibrational states which are close approximations to those of Morse, with comparatively little labour. The transition probabilities obtained from these functions are compared with experimental values for the first negative bands of N_2^+, the Swan bands of C_2, the CN violet bands, and the α-system of BO. A.

539.132 : 535.343–15

9632. C = O vibrations (fundamental and harmonics) studied by means of the infra-red absorption of ketones. L. RECART. *C.R. Acad. Sci., Paris*, **233**, 383–5 (*July* 30, 1951) *In French.*

Measurements in the region 1–5·8 μ up to the 6th harmonic. The formula of Kratzer $\nu_n =$

$\nu_0(1 - nx)$, where n = order of harmonic and x = constant holds fairly well except for the 3rd and 4th harmonics; these vibrations are probably perturbed by C–H vibrations of adjacent groups. For a given ketone there is a linear relation between n and log of absorption coefficient (ε). For a given harmonic in aliphatic ketones, ε is greater for larger attached groups. G. F. LOTHIAN

539.133

9633. The asymmetric rotor. IX. The heavy water bands at 2787 cm^{-1} and 5373 cm^{-1}. K. K. INNES, P. C. CRÖSS AND P. A. GIGUÈRE. *J. Chem. Phys.*, **19**, 1086–8 (*Sept.*, 1951).

For Pt VIII, see Abstr. 7132 (1950). The combination band (110) of the two stretching fundamentals of D_2O is reported and analysed to yield $\nu_0 = 5373{\cdot}2$ cm^{-1} and the excited state moments of inertia $1{\cdot}910$, $3{\cdot}931$ and $5{\cdot}929 \times 10^{-40}$ g cm^2. The same method of analysis applied to the unsymmetrical fundamental band (100) envelope gives $\nu_0 = 2787{\cdot}5$ cm^{-1} and the excited state moments $1{\cdot}881$, $3{\cdot}876$ and $5{\cdot}843 \times 10^{-40}$ g cm^2. A.

539.133 : 548.7

9634. Study of lithium sulphate monohydrate by nuclear magnetic resonance. M. SOUTIF, B. DREYFUS AND Y. AYANT. *C.R. Acad. Sci., Paris*, **233**, 395–7 (*July* 30, 1951) *In French.*

The half-width and second moment of the proton nuclear resonance of $Li_2SO_4 . H_2O$ have been used to show that the two H atoms of each H_2O are $1{\cdot}57$ Å apart on a line at 46° to the binary axis.

D. H. WHIFFEN

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1 : 539.172.3

9635. Erratum. Theory of H^3 and He^3 photodisintegration and formation. M. VERDE. *Helv. Phys. Acta*, **24** (*No.* 3) 298 (1951) *In German.*

See Abstr. 7434 (1950).

539.152.2

9636. On the deviations of magnetic moments from the Schmidt lines. A. DE-SHALIT. *Helv. Phys. Acta*, **24** (*No.* 3) 296–7 (1951).

Notes that, in a plot of magnetic moment ν spin, all known moments (with two exceptions) lie between the Schmidt lines and the Dirac lines (obtained by giving the nuclear g-factors their free values and their Dirac values resp.). R. H. DALITZ

539.152.2

9637. $^{176}_{71}$Lu and the nuclear shell model. P. F. A. KLINKENBERG. Letter in *Physica*, **17**, 715–16 (*July*, 1951).

The magnetic moments resulting from all possible combinations of a proton in a $5g_{7/2}$, $4d_{5/2}$, $6h_{11/2}$, $4d_{3/2}$ or $3s_{1/2}$ state and a neutron in a $5f_{5/2}$, $7i_{13/2}$, $4p_{3/2}$ or $4p_{1/2}$ state have been calculated for two different assumed spin g-factors. Agreement with experiment is best for $I = 10$ and this suggests a $6h_{11/2}$ odd proton and a $7i_{13/2}$ odd neutron. W. J. SWIATECKI

539.152.2

9638. On the study of lines of weak intensity in nuclear resonance. P. GRIVET. *C.R. Acad. Sci., Paris*, **233**, 397–9 (*July* 30, 1951) *In French.*

A theoretical investigation of the conditions for using the variation of nuclear resonance signal with modulation amplitude as a criterion for distinguishing Bloch–Lorentz from Gaussian line shapes when the signals are too close to noise to measure the shape directly. D. H. WHIFFEN

539.152.2

9639. Nuclear magnetic resonance effects in metals: temperature effects for Na^{23}. H. S. GUTOWSKY. Letter in *Phys. Rev.*, **83**, 1073 (*Sept.* 1, 1951).

A large increase of line width for Na metal dispersed in oil below 190°K is attributed to the freezing of self-diffusion. D. H. WHIFFEN

539.152.2

9640. Nuclear relaxation in gases by surface catalysis. F. BLOCH. Letter in *Phys. Rev.*, **83**, 1062 (*Sept.* 1, 1951).

A theoretical treatment of nuclear relaxation of monatomic gases by collision with a paramagnetic powder shows that the longitudinal relaxation time $T_1 = 4V/w\bar{v}S$ where V is the volume of the gas, S the surface area of the powder, w the transition probability per collision and v the mean gas velocity; this agrees in order of magnitude with experiments for He and Fe_2O_3. D. H. WHIFFEN

539.152.2

9641. Nuclear relaxation times in metallic Na^{23}. R. E. NORBERG AND C. P. SLICHTER. Letter in *Phys. Rev.*, **83**, 1074 (*Sept.* 1, 1951).

Measurements of the two relaxation times T_1 and T_2' were carried out between −58° and +80°C; T_1 was found to be inversely proportional to the temperature; the low temperature dependence of T_2' ("spin phase-memory") is discussed by means of a theoretical model assuming diffusion of Na nuclei. Above −25°C T_2' is of the same order as T_1, the spin-lattice interaction relaxation time. E. P. WOHLFARTH

539.152.2

9642. Amplitude measurements of nuclear signals. G. CHIAROTTI AND L. GIULOTTO. Letter in *Nuovo Cim.*, **8**, 595–7 (*Aug.*, 1951) *In Italian.*

A description of a method for absolute amplitude determinations. L. PINCHERLE

539.152.2

9643. Measurement of the F^{19} magnetic moment. T. KANDA, Y. MASUDA, R. KUSAKA, Y. YAMAGATA AND J. ITOH. Letter in *Phys. Rev.*, **83**, 1066 (*Sept.* 1, 1951).

Experiments on HF aq. give $\mu_{F^{19}}/\mu_H = 0{\cdot}940814 \pm 0{\cdot}000009$ without diamagnetic correction.

D. H. WHIFFEN

539.152.2 : 538.222

Quadrupole moments of copper 63 and 65. *See Abstr.* 9605

539.153

9644. Some line strengths for ionized neon. R. H. GARSTANG. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 612–14 (1950).

Transition integrals and *f*-values have been calculated for the arrays $3s - 3p$, $3p - 3d$, and $3d - 4f$ of Ne II using both the Coulomb approximation and the method of the self-consistent field, without exchange. The mean square radii of the outer orbitals are also given. A.

539.153

9645. The outer electron configuration in metallic copper. A. I. SNOW. *J. Chem. Phys.*, **19**, 1124–7 (*Sept.*, 1951).

The effect on the atomic scattering factor of metallic Cu of the $3d^{7\cdot75}4s^{1}\,4p^{2\cdot25}$ outer electron configuration, demanded by the Pauling valence of 5·50, is computed. Approximately a 6% lowering in intensity of the (111) reflection when compared with the atomic scattering factor computed on the basis of a Hartree–Fock calculation for the $3d^{10}\,4s^{1}$ configuration is predicted if the Pauling model is the correct one. Differences for other reflections are also computed. Available intensity data for metallic Cu are discussed in the light of these results. A.

539.155.2

9646. Separation of stable isotopes by electromagnetic means. W. D. ALLEN. *Nature, Lond.*, **168**, 451–3 (*Sept.* 15, 1951).

Plants for the separation of amounts of the order of some tens of grams (occasionally hundreds) are in operation at Oakridge (U.S.A.) and Harwell (G.B.). The enrichment factor varies between approximately 20 and 1 000, and almost all polyisotopic elements can be so treated. This article gives a brief review of the characteristics peculiar to this method of isotope separation. Some examples are given of the application of enriched isotopes in: nuclear physics research; spectroscopic work; medical tracer work (e.g. radio Fe made by *n*-irradiation of Fe^{58} has a half-life of 46 days, while the use of natural Fe would introduce the harmful 4-yr Fe^{55}); superconductivity experiments.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

9647. Natural radioactivity of water. S. K. LOVE. *Industr. Engng Chem.*, **43**, 1541–4 (*July*, 1951).

The available information on U^{238}, Ra^{226} and Th^{232} present in natural waters is surveyed. Sea water has been found to contain $1\cdot1 - 1\cdot7 \times 10^{-6}$ g of U and $0\cdot08 \times 10^{-12}$ g of Ra per litre (only about one-seventh of the amount in equilibrium with the U). An upper limit of $0\cdot5 \times 10^{-6}$ g/l has been set on the Th content of sea water. Normal surface and ground waters contain from $0\cdot1$ to 10×10^{-12} g of Ra per litre. Mineralized springs contain greater concentrations of Ra than this and some thermal springs contain $> 5 \times 10^{-7}$ g per litre. L. R. SHEPHERD

539.16.08

9648. The absolute standardization of radioisotopes by 4π counting. H. H. SELIGER AND L. CAVALLO. *J. Res. Nat. Bur. Stand., Wash.*, **47**, 41–4 (*July*, 1951).

The absolute counting of beta-particles, using 4π proportional flow counters, is described. This method of absolute counting has been adopted in the Radioactivity Section of the National Bureau of Standards for the primary calibration of radioisotope solution standards. Pillbox, cylindrical and spherical 4π flow counters have been used in the measurements, and excellent results have been obtained for each. A simple method of source mounting has been developed and a formula is derived that determines the absorption in the source mounting regardless of knowledge of the thickness of the mounting or energy spectrum of the beta rays. Results are given of intercomparisons of P^{32} and I^{131} with other laboratories in the United States, Canada and Great Britain that employ different types of absolute counting techniques. The applicability of the 4π counting method to the standardization of practically all beta-emitting radiosotopes is discussed. A.

539.16.08

9649. Efficiency criteria in radioactivity counting. R. LOEVINGER AND M. BERMAN. *Nucleonics*, **9**, 26–39 (*July*, 1951).

The conditions are derived determining the number of sample and background counts which must be made to reach a desired percentage error in a minimum time. Comparisons are made with other methods, including the use of a fixed ratio of sample to background counts, fixed counting time ratio and counting to obtain equal standard errors in both sample and background measurements. The criteria determining the merit of a counter for minimum time counting and the optimum operating conditions for scintillation and proportional counters are discussed. L. R. SHEPHERD

539.16.08

9650. Counting of radioactivity in liquid samples. R. F. GODDU AND L. B. ROGERS. *Science*, **114**, 99–100 (*July* 27, 1951).

Describes errors in counting due to plating-out of radioactive metal and to evaporation of the liquid when using the technique of Freedman and Hume [Abstr. 1261 (1951)]. L. E. MUSSELL

539.16.08

9651. Preparation of uniform solid samples for radioactive assay. M. L. WRIGHT. Letter in *Nature, Lond.*, **168**, 289–90 (*Aug.* 18, 1951).

For counting beneath an end-window G–M counter very uniform samples are prepared by rapidly evaporating solution on to the central portion of aluminium disks freshly turned on a lathe. L. E. MUSSELL

539.16.08 : 537.591.08 : 539.172 : 778.3

Photographic emulsion technique. *See Abstr.* 9896

539.16.08 : 578

9652. Errors in determination of specific activity and turnover rates of radioactive isotopes. A. H. ENNOR AND H. ROSENBERG. Letter in *Nature, Lond.*, **168**, 199–200 (*Aug.* 4, 1951).

A serious error has been detected in the results

obtained by the use of conventional techniques in experiments designed to investigate the turnover rates of certain organophosphates by the use of P^{32}. Results indicate the presence of a compound containing P^{32} which does not react with the molybdate to form a phosphomolybdate complex, and so remains insoluble in isobutanol. Preliminary experiments indicate that the adenosine polyphosphates are co-precipitated and the degree of co-precipitation is dependent upon the amount of carrier phosphorus which has been added. T. A. CHALMERS

539.16.08 : 578

9653. A particulate impurity found in solutions of radioactive phosphorus. J. E. HOTCHIN. Letter in *Nature, Lond.*, **168,** 200 (*Aug.* 4, 1951).

At various times during 1950, an appreciable proportion of activity was found associated with particulate matter in samples of carrier free radioactive orthophosphate. Recent samples of P^{32} have been free from this impurity. It is concluded that if reliable results are to be obtained from experiments involving proteins labelled with P^{32} it is essential to ensure that the tracer solution is free from this impurity. Filtration through a $0{\cdot}25\,\mu$ "Gradocol" membrane after addition of the carrier, provides a reliable and simple method of doing this, while at the same time sterilizing the solution. T. A. CHALMERS

539.16.08 : 612.483

9654. Measurements of radiation from the human body. R. M. SIEVERT. *Ark. Fys.*, **3,** *Paper* 18, 337–46 (1951).

The subject to be measured was placed inside a ring of 10 long ionization chambers filled with N_2 at pressure. Using an electrometer valve and galvanometer the ionization current was recorded photographically, readings lasting about 2 hours and alternating with a $0{\cdot}1\,\mu$g Ra standard. An attempt has been made to screen the apparatus against cosmic radiation and gamma-ray background, but the effect of the latter was still important as shown by the absorption in a water-filled rubber dummy. Twelve "normal" and twelve "contaminated" subjects were measured and the results corrected for K^{40} in the body and Rn excreted. The Ra content at 50 years of age in a normal person was about 80×10^{-10} g, the accuracy of the reading under favourable conditions being $\pm20\times10^{-10}$ g with possible systematic errors of the same order. Ways of improving the accuracy are described. L. E. MUSSELL

539.161, 539.165

9655. Radioactive I^{122}. J. N. YOUNG, M. L. POOL AND D. N. KUNDU. Letter in *Phys. Rev.*, **83,** 1060 (*Sept.* 1, 1951).

A 3·6 min I activity was obtained by bombarding Te with 7·4 MeV protons, and the use of isotopically enriched Te samples identified it as I^{122} [see Abstr. 8188 (1950)] assuming the (p, γ) reaction to be rare, as it is with Te^{124} and Te^{125}. Positron $E_{max} = 3{\cdot}08 \pm 0{\cdot}1$ MeV.

539.163

9656. The radiations of Tl^{199} and Tl^{200}. H. I. ISRAEL AND R. G. WILKINSON. Letter in *Phys. Rev.*, **83,** 1051 (*Sept.* 1, 1951).

Nine γ-rays are listed from Tl^{199} and five from Tl^{200}. The former agree in some cases with γ-rays reported from the decay of Au^{199} [Abstr. 2653 (1950)]. B. ROSE

539.163

9657. Neutron deficient europium and gadolinium isotopes. R. W. HOFF, J. O. RASMUSSEN AND S. G. THOMPSON. Letter in *Phys. Rev.*, **83,** 1068 (*Sept.* 1, 1951).

Radiations and half-lives are reported for the isotopes Eu^{145}, Eu^{146}, Eu^{147}, Eu^{148} and Gd^{149}, produced by the bombardment of samarium and europium. B. ROSE

539.163.1

9658. The interpretation of isomeric transitions. S. A. MOSZKOWSKI. Letter in *Phys. Rev.*, **83,** 1071 (*Sept.* 1, 1951).

The half-life of nuclear isomeric states as a function of γ-ray energy, nuclear radius R, and type and multipole order of radiation has been calculated assuming only one proton to be involved and replacing radial integrals by the appropriate power of R. The results serve as a basis for the classification of experimental data. W. J. SWIATECKI

539.163.1.08

9659. The determination of the decay constant of a radioactive source. I. N. HOLE. *K. Norske Vidensk. Selsk. Forhandl.*, **32** (*No.* 8) 30–3 (1591).

The most probable value of the decay constant and its sampling distribution are obtained in terms of the number of disintegrations occurring in a source in a given time. W. J. SWIATECKI

539.163.1.08

9660. The determination of the decay constant of a radioactive source. II. N. HOLE. *K. Norske Vidensk. Selsk. Forhandl.*, **32** (*No.* 9) 34–7 (1951).

The calculations of the preceding Abstr. are generalized to the case when the numbers of disintegrations in r equal intervals are given. W. J. SWIATECKI

539.163.2

9661. On the disintegration of 8·0d ^{131}I. G. J. NIJGH, N. F. VERSTER, R. H. NUSSBAUM, R. VAN LIESHOUT AND C. J. BAKKER. Letter in *Physica*, **17,** 658–60 (*July*, 1951).

An absorption curve of that part of the β-spectrum which is in coincidence with K-conversion electrons of the 80 keV γ-radiation gave results in agreement with the level scheme of Metzger and Deutsch [Abstr. 2700 (1949)]. B. ROSE

539.163.2

9662. Investigations on the β activity of boron-12 and lithium-8. G. VENDRYES. *C.R. Acad. Sci., Paris*, **233,** 391–3 (*July* 30, 1951) *In French.*

Refinement of previous measurements [Abstr. 6415 (1951)] has shown that $4 \pm 1\%$ of the β-disintegrations of B^{12} lead to a γ-emitting state of C^{12}, probably the 4·5 MeV state. The allowed character of transitions to both the ground and excited states of C^{12} ($\log ft = 4{\cdot}2$ and 4·8 respectively) may be accounted for by Gamow–Teller selection rules, assigning spin $J = 1$ to B^{12} and to the excited state of C^{12}. Similar experiments on Li^8 indicated a β end-point of $6{\cdot}8 \pm$

$0\cdot4$ gm/cm^2 of carbon and a weak $\beta\gamma$ coincidence effect. The latter is tentatively attributed to a $2 \pm 1\%$ branch ($\log ft = 7$) leading to the 4·9 MeV level of Be^8. J. J. WILKINS

539.163.2

9663. *K* capture in I^{128}. W. B. MIMS AND H. HALBAN. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 753–4 (*Aug.*, 1951).

X-rays emitted by I^{128} were observed by means of an NaI (Tl activated) scintillation counter and a pulse analyser. Comparison with In^{114} *K* X-rays showed that they were Te *K*-radiation; they were not in coincidence with the β-particles. A *K*-capture to β-decay branching ratio of $6\cdot3 \pm 0\cdot7 \times 10^{-2}$ was found. L. R. SHEPHERD

539.163.2

9664. Decay of 10·7-min Co^{60m}. M. DEUTSCH AND G. SCHARFF-GOLDHABER. Letter in *Phys. Rev.*, **83**, 1059 (*Sept.* 1, 1951).

$0\cdot28 \pm 0\cdot06\%$ direct decay to the 1·33-MeV state of Ni^{60} is reported. Spin and parity assignments are discussed. J. J. WILKINS

539.163.2 : 539.172

9665. On the isomerism of Sb-120. J. P. BLASER, F. BOEHM, P. MARMIER AND H. WÄFFLER. *Helv. Phys. Acta*, **24** (*No.* 3) 245–6 (1951) *In German.*

Sb was bombarded with 6·8 MeV protons, X-rays from a 32 MeV betatron, and Li–D neutrons; no trace of a 6-day isomer of Sb^{120} [Abstr. 3444 (1948)] could be obtained. A. O. STANESBY

539.165

9666. Theory of beta-decay. M. A. PRESTON. *Nat. Res. Coun. Can., Publ. No.* 2396, 88 *pp.* (1950).

An account of the theory developed from the beginning and based on 7 lectures delivered in 1950. The contents include discussions of spectral shapes, neutrino mass, decay constant, Coulomb effects, *K*-capture, decay of ionized atoms, self-capture, e–γ angular correlations, neutron decay. A chapter is devoted to forbidden transitions and part of another to the additional selection rules of Bouchez [*C.R. Acad. Sci., Paris*, **230**, 440 (*Jan.* 30, 1950)] and Nataf [Abstr. 5229, 6715 (1950)]. The theory is illustrated with a large selection of experimental results.

W. J. SWIATECKI

539.165

9667. Beta-ray spectrum of K^{40}. M. L. GOOD. Letter in *Phys. Rev.*, **83**, 1054 (*Sept.* 1, 1951).

This was measured from the analysis of the scintillations in an KI–Tl crystal. The Kurie plot assuming a third forbidden transition was linear. The specific β-decay rate of $27\cdot1 \pm 0\cdot6$ β/sec/g K agreed well with other determinations [Abstr. 8934 (1950)]. B. ROSS

539.165 : 530.145

Relativistic wave-functions and *K*-capture for a modified Coulomb field. *See Abstr.* 9283

539.165/.166 : 537.533.72

9668. Spectroscopy of beta- and gamma-rays. P. E. CAVANAGH. *Progress in Nuclear Physics*, 1. *London, Butterworth-Springer; New York, Academic Press* (1950) 140–67.

This review commences with a brief description and first-order theory of the following spectrometers: semicircular focusing; solenoid; magnetic lens; double focusing; radial inhomogeneous field semicircular focusing; four pole, and magnetic prism; pair spectrometer; spherical electrostatic field. The next section deals with measurement of gamma-ray energies, followed by measurement of spin changes associated with gamma-ray transitions. Measurement of maximum energy of β-rays is next discussed, and the review concludes with a discussion on nuclear level schemes. (Bibliography of 63 refs.).

539.165.2 : 530.145

9669. Double beta-decay as a first-order process. R. G. WINTER. Letter in *Phys. Rev.*, **83**, 1070 (*Sept.* 1, 1951).

A term is added to the Fermi Hamiltonian which couples two electrons to the nucleus in the same manner as that used in Fermi theory to couple one electron and one neutrino to the nucleus. The transition probabilities for scalar, vector and ps.-scalar interactions are given in terms of the energies of the electrons and the angle between them.

W. J. SWIATECKI

539.165.2 : 539.18

9670. A proposal on the measurement of the recoil spectrum using gas source. T. OHKAWA. Note in *J. Phys. Soc. Japan*, **6**, 197 (*May–June*, 1951).

In an axially symmetric field of the form $V = (k/2)(x^2 + y^2 - 2z^2)$ the distance $\rho = v_0/\alpha$ of a particle of charge e, mass m from the origin at a time $T = \pi/2\alpha$ after its formation is independent of its initial position and depends only on its initial velocity v_0, and k, ($\alpha = k \,.\, e/m$), neglecting motion in the z-direction. An annular ion detector in delayed coincidence with a β-detector could be used to obtain a velocity spectrum of the recoil nuclei.

A. O. STANESBY

539.166

9671. γ-radiation from Ag^{110}. B. S. DZHELEPOV, N. N. ZHUKOVSKIĬ AND YU. V. KHOLNOV. *Dokl. Akad. Nauk, SSSR*, **77** (*No.* 4) 597–8 (1951) *In Russian.*

Experimental conditions were the same as in Abstr. 6433 (1951). Results are in fair agreement with Siegbahn [Abstr. 4311 (1950)], but the 885 and 930 keV lines were not separated. J. C. E. JENNINGS

539.166

9672. Gamma-radiation from lanthanum 140. J. M. CORK, A. E. STODDARD, J. M. LEBLANC, C. E. BRANYAN, D. W. MARTIN AND W. J. CHILDS. Letter in *Phys. Rev.*, **83**, 856 (*Aug.* 15, 1951).

Twenty-four electron lines have been observed and interpreted as due to fifteen gamma-ray lines. A level scheme for Ce^{140} is proposed. B. ROSE

539.166

9673. Erratum: Three-crystal scintillation spectrometer. J. K. BAIR AND F. C. MAIENSCHEIN. *Rev. Sci. Instrum.*, **22**, 672 (*Sept.*, 1951).

See Abstr. 6440 (1951).

539.166

9674. Radiative transition probabilities in nuclei. V. F. Weisskopf. Letter in *Phys. Rev.*, **83**, 1073 (*Sept.* 1, 1951).

These are calculated for 2^l-pole electric and magnetic radiations assuming only one proton to be involved and replacing radial integrals by $3R^l/(l+3)$.

W. J. SWIATECKI

539.166

9675. The ratio of L to K electron capture for Os^{185}. M. M. Miller and R. G. Wilkinson. Letter in *Phys. Rev.*, **83**, 1050 (*Sept.* 1, 1951).

The ratio was found to be $0{\cdot}35 \pm 0{\cdot}15$, and the theoretical significance discussed. Ratios of the L to K X-radiation are reported for Re^{184}, Tl^{199} and Tl^{200}.

B. ROSE

539.166

9676. 31-keV excited state of aluminium-28. R. D. Smith and R. A. Anderson. Letter in *Nature, Lond.*, **168**, 429–30 (*Sept.* 8, 1951).

Gamma-radiation of energy $31{\cdot}4 \pm 1{\cdot}0$ keV was observed, but no internal conversion electrons could be detected, indicating $\alpha_K < 2\%$ and an electric dipole transition.

J. J. WILKINS

539.166

9677. A note on isotropy in nuclear gamma-radiation. G. B. Arfken, L. C. Biedenharn and M. E. Rose. *Phys. Rev.*, **84**, 89–91 (*Oct.* 1, 1951).

The question of the possibility of competing radiations exhibiting different angular distributions (in the sense that one radiation is isotropic and another anisotropic) is investigated. Except for the singular cases $\frac{3}{2} \to \frac{3}{2}$ and $5 \to 4$ by quadrupole emission, the conclusion is as follows: if one radiation of multiple order 2^L is observed to be isotropic, all competing gamma-radiation will be isotropic if $L \geqslant j - \frac{1}{2}$, where j is the angular momentum of the emitting state. The possibility of occurrence of singular cases, for which the conclusion would not apply, has been investigated for all radiations for which $L \leqslant 3$. In the case $\frac{3}{2} \to \frac{3}{2}$, $L = 2$ the radiation is isotropic and the applicability of this to the problem of the excited state of Li^7 is briefly discussed.

A.

539.166.83

9678. On the connection between K-capture and γ-emission in potassium 40. M. Paganelli and G. Quareni. Letter in *Nuovo Cim.*, **8**, 598–600 (*Aug.*, 1951) *In Italian.*

A direct proof is given of the coincidence between the emission of Auger electrons, following K-capture, and the emitted γ-rays.

L. PINCHERLE

539.166.83

9679. The conversion and Auger electrons of radium D. D. K. Butt and W. D. Brodie. *Proc. Phys. Soc., Lond. A*, **64**, 791–6 (*Sept.*, 1951).

The conversion and Auger electrons of Ra D have been studied in a lens β-ray spectrometer with a post-focusing electron accelerator. The number of conversion electrons due to the 46·7 keV γ-ray is found to be $59{\cdot}2 \pm 5$ per hundred disintegrations but reasons are given which suggest that this value be regarded as a lower limit. The Auger electrons have been compared with those resulting from the ThB–ThC transition.

A.

539.166.93 : 541.15

The Szilard–Chalmers process. *See Abstr.* 9778

539.167.3

9680. The carrier-free extraction of radioactive indium from "Irradiated Unit Sb^{125}." K. Kimura and N. Ikeda. *J. Sci. Res. Inst., Tokyo*, **45**, 128–32 (*July*, 1951).

In^{113m} can be extracted in the carrier-free form from "Irradiated Unit Sb^{125}" by a very simple procedure. The extraction can be repeated for relatively long periods about once a day. In^{113m} thus extracted can be used as the tracer for indium. The method of extraction is described in detail. The absorption curve of In^{113m} for aluminum foil was also investigated.

A.

539.167.3

9681. New method of preparing carrier-free artificial radioelements. Case of S^{35}. M. Chemla and P. Süe. *C.R. Acad. Sci., Paris*, **233**, 247–9 (*July* 16, 1951) *In French.*

P^{32} and S^{35} produced by fast neutrons in NaCl diffuse to the surface of a heated crystal. S^{35} is taken off in a current of H_2 as H_2S, and the P^{32} is carried away by the NaCl vapour.

R. H. DAVIES

539.167.3 : 778.33

Gamma radiography in the United Kingdom. *See Abstr.* 9897

NUCLEAR REACTIONS 539.17

539.17 : 523.112

9682. Neutron-capture theory of element formation in an expanding universe. R. A. Alpher and R. C. Herman. *Phys. Rev.*, **84**, 60–8 (*Oct.* 1, 1951).

The neutron-capture theory of element formation by non-equilibrium processes has been extended to include explicitly the effect of the expansion of the universe, and the resulting equations have been solved on an electronic digital computing machine. Inclusion of the universal expansion is found to require an increase by a factor of five of the density of matter chosen for the start of the element-forming process over that previously found necessary to represent the observed relative abundance distribution of elements in a static universe. The following physical conditions lead to agreement in the over-all trend of theoretical with observed abundances: the element-forming process is taken to start at ~ 140 sec after the "beginning" of the universal expansion; at this time the temperature is $\sim 1{\cdot}3 \times 10^{9\circ}$K $= 0{\cdot}11$ MeV, the neutron-proton ratio is $7{\cdot}33 : 1$, and the density of matter is $\sim 0{\cdot}9 \times 10^{-6}$ g/cm^3. This density value includes a correction made to account for the effect of grouping together nuclear species in order to reduce the number of differential equations required to describe the neutron-capture process. The effect of the choice of an initial neutron-

proton ratio on the other physical conditions involved in representing the observed relative abundance data is considered. A neutron-proton starting ratio of 1 : 4, recently found by Hayashi to result from the interactions between matter and radiation in the pre-element-forming phase of the expanding universe, is shown to lead to some difficulties. In an Appendix, T. H. Berlin shows that the differential equations describing the element-forming process can be solved in closed form for the static case by the use of Laplace transforms. However, the inclusion of the universal expansion precludes solution in closed form. A.

539.17 : 537.591.08 : 539.16.08 : 778.3

Photographic emulsion technique. *See Abstr.* 9896

539.17 : 778.3

Cylindrical emulsions. *See Abstr.* 9902

539.17 : 778.34

Apparatus for searching and measuring particle-sensitive plates. *See Abstr.* 9901

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 9576–83

539.172

9683. Stars produced in nuclear emulsions by carbon ions from the cyclotron. J. F. Miller. Letter in *Phys. Rev.*, **83**, 1261 (*Sept.* 15, 1951).

539.172

9684. Nuclear interaction of μ-mesons underground. S. Hayakawa. *Phys. Rev.*, **84**, 37–43 (*Oct.* 1, 1951).

The nuclear interactions of μ-mesons and the genetic relations among their secondary particles are analysed on the basis of the data obtained with photographic plates exposed underground by George and Evans. The results are used to analyse the experiment performed by Cocconi and Tongiorgi, in which the neutron showers produced in an absorber at different depths of water were studied. The contributions to the neutron showers from various components are compared. It is shown that the μ-mesons directly producing neutron showers in the absorber and the nucleons produced by the μ-mesons in the water above the apparatus and interacting in the absorber give the main contribution to the large neutron showers observed. The multiplicity spectrum of the neutrons is calculated by making use of a simplified model of the nucleon cascade and is shown to depend upon the selection bias of the detecting apparatus. The experimental results are consistently accounted for by assuming for the μ-mesons a nuclear interaction cross-section of $\sim 10\,\mu$b per nucleon. The experiments at great depths suggest the predominance of small momentum transfers by nuclear collisions. The large cross-section and the small momentum transfer can be described in terms of the virtual photons associated with μ-mesons. These virtual photons produce in nuclear collisions real or virtual π-mesons which can either escape or be absorbed in the nucleus. A.

539.172 : 537.591.1

9685. Nuclear disintegrations induced by μ-mesons. G. Cocconi and V. Cocconi Tongiorgi. *Phys. Rev.*, **84**, 29–36 (*Oct.* 1, 1951).

The absorption curve in water of the cosmic radiation producing nuclear disintegrations was obtained by recording the neutron showers occurring in an absorber surrounded by BF_3 counters. It was found that, while the N-component of the cosmic radiation is responsible for most of the disintegrations observed under the first few meters of water, μ-mesons are the particles causing directly or indirectly most of the events recorded at depths greater than ~ 10 m water. The cross-section of μ-mesons for nuclear interactions is found to be $\sim 1 \times 10^{-29}$ cm^2/nucleon at a depth of 20 m water. Estimates of the absolute intensity of the N-component and of the relative contribution to nuclear disintegrations by μ-mesons and N-component at sea level are given. A.

539.172.11

9686. The reaction $C^{13}(\alpha n)O^{16}$. G. A. Jones and D. H. Wilkinson. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 756 (*Aug.*, 1951).

Neutrons emitted in the bombardment of C^{13} by 1·05 MeV α-particles, were detected in a 38 atmosphere deuterium filled ionization chamber, and their energy estimated to be $2{\cdot}68 \pm 0{\cdot}15$ MeV from a pulse-height analysis of the recoil deuterons compared with a value of 2·92 MeV deduced from the atomic masses. L. R. Shepherd

539.172.11/.13

9687. Coulomb functions for reactions of protons and alpha-particles with the lighter nuclei. I. Bloch, M. H. Hull, Jr, A. A. Broyles, W. G. Bouricius, B. E. Freeman and G. Breit. *Rev. Mod. Phys.*, **23**, 147–82 (*April*, 1951).

New tables of Coulomb functions are presented along with an introduction to their use. The ranges of parameters covered by the tabulations are those required for the calculation of reactions of protons, deuterons and alpha-particles with the lighter nuclei, from H to O, in the energy range of a few MeV. For alpha-particles the tables suffice for treatment of reactions up to about 10 MeV for $Z = 9$ (F) and 5 MeV for $Z = 2$ (He), while for protons the energy range covered is about 4× that for alpha-particles. An indication of the principal applications of Coulomb functions is given. A.

539.172.13

9688. Experimental investigations of proton capture processes in light elements. R. Tangen. *K. Norske Vidensk. Selsk. Skr., No.* 1, 91 *pp.* (1946).

(p, γ) reactions in Li, Be, B, C, N, O, F, Na, Mg, Al, Si, P and Cl were investigated with protons of 100–550 keV energy, accelerated by a van de Graaff machine; values are given for the resonance energies, and in some cases the resonance half-widths. The resonance energies for Li^7 and F^{19}, suggested as standards, were 440 ± 2 and 339 ± 2 keV.

A. O. Stanesby

539.172.13

9689. A search for emission of electron pairs from nuclei. G. C. Phillips, D. B. Cowie and N. P. Heydenburg. Letter in *Phys. Rev.*, **83**, 1049 (*Sept.* 1, 1951).

Pairs were observed from proton bombardment of B^{11}, but not from B^{10}, Na, Al, P, Li, Be, Ag, and C.

B. Rose

539.172.13

9690. High-energy protons emitted from carbon at 90° to a 240-MeV proton beam. G. M. TEMMER. Letter in *Phys. Rev.*, **83**, 1067 (*Sept.* 1, 1951).

Emitted proton energies of up to 150 MeV are reported, and the implications are discussed.

J. J. WILKINS

539.172.13

9691. On the angular distribution and the polarization of the deuteron in the reaction $p + p \rightarrow d + \pi^+$. K. M. WATSON AND C. RICHMAN. Letter in *Phys. Rev.*, **83**, 1256 (*Sept.* 15, 1951).

539.172.13

9692. Yields of α-, *n*-, and γ-radiation from chlorine bombarded with protons. K. J. BROSTRØM, B. S. MADSEN AND C. B. MADSEN. Letter in *Phys. Rev.*, **83**, 1265 (*Sept.* 15, 1951).

539.172.13

9693. The elastic scattering and capture of protons by oxygen. R. A. LAUBENSTEIN, M. J. W. LAUBENSTEIN, L. J. KOESTER AND R. C. MOBLEY. *Phys. Rev.*, **84**, 12–18 (*Oct.* 1, 1951).

The yield of elastically scattered protons from oxygen was measured with a magnetic analyser which detected protons scattered through laboratory angles of 159° to 169°. Using protons accelerated by an electrostatic generator, the proton energy range from 0·6 to 4·5 MeV was covered in 4·4-keV or smaller steps. Two sharp resonances were observed, one at an incident proton energy of 2·66 MeV with a width of 19·9 keV, and the second at 3·47 MeV with an observed width less than 3·5 keV. Near 4·0 MeV a broad maximum in the cross-section was obtained, and a broad resonance appears to give another maximum slightly above 4·5 MeV. The resonance at 2·66 MeV appeared as a nearly symmetrical dip in the scattering cross-section. The capture cross-section of oxygen for protons was measured for incident proton energies from 1·4 to 4·1 MeV by counting the positrons from the decay of F^{17} built up under the bombardment of oxide targets. Up to a narrow resonance at 3·47 MeV, the capture cross-section was observed to increase almost linearly with energy. Above 3·75 MeV, the cross-section was found to increase more rapidly to a maximum near 3·99 MeV. On the basis of the scattering and capture data, energy levels have been assigned to F^{17} at 3·11, 3·88, 4·36 and 4·73 MeV, although the positions of the latter two levels are not clearly defined by the data. A.

539.172.13 : 539.152.2

9694. Assignment of angular momenta to the energy levels of F^{17}. R. A. LAUBENSTEIN AND M. J. W. LAUBENSTEIN. *Phys. Rev.*, **84**, 18–28 (*Oct.* 1, 1951).

An analysis of data on the elastic scattering and capture of protons by O was made for the purpose of assigning angular momenta to certain energy levels in F^{17}. The elastic scattering data were analysed using a graphic method wherein the phase and amplitude of the refracted partial waves are represented by vectors in the complex plane. As the proton energy is varied over a resonance, a circular locus is obtained for the vector which represents the component of a partial wave which excites the resonance. Assignments of angular momenta to the energy levels of F^{17} have been made as follows: ground state, $D_{\frac{5}{2}}$; 0·55 MeV, $S_{\frac{1}{2}}$; 3·11 MeV, $S_{\frac{1}{2}}$; 3·88 MeV, $F_{\frac{7}{2}}$; 4·36 MeV, $D_{\frac{3}{2}}$; and 4·73 MeV, $P_{\frac{3}{2}}$. The assignments of the 0·55-MeV, 3·11-MeV, and 3·88-MeV levels are reasonably certain, but the others are based on less substantial evidence. The reduced width of the 3·11-MeV $S_{\frac{1}{2}}$ level was found to be about $0{\cdot}048 \times 10^{-13}$ MeV-cm, while the 0·55-MeV $S_{\frac{1}{2}}$ level probably has a reduced width over 100 times as large. The slowly rising capture cross-section observed from 1·4 to 3·4 MeV is probably caused by the broad 0·55-MeV level. A comparison of the levels in the mirror nuclei, O^{17} and F^{17}, shows a similar structure. A.

539.172.13

9695. Magnetic analysis of α-particle groups from (*d*, α) reactions. A. ASHMORE AND J. F. RAFFLE. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 754–6 (*Aug.*, 1951).

A 50° sector-field spectrometer was used to measure the energies of α-particles emitted in the bombardment of C, O and Mg by 6·77 and 5·31 MeV deuterons. Two α-particle groups observed in the $C^{12}(d, \alpha)B^{10}$ reaction corresponded to transitions to the ground state and a 0·71 MeV level of B^{10}. Three groups from the reaction $O^{16}(d, \alpha)N^{14}$ were attributed to transitions to levels of 5·70, 5·01 and 3·95 MeV in N^{14}. A 4·32 MeV α-particle group was obtained in the Mg bombardment. L. R. SHEPHERD

539.172.13

9696. Angular distribution of the two long-range neutron groups of the reaction $O^{16}(d, n)F^{17}$. F. EL-BEDEWI, R. MIDDLETON AND C. T. TAI. Letter in *Proc. Phys. Soc., Lond. A*, **64**, 756–7 (*Aug.*, 1951).

The neutron spectra and angular distribution, in the reaction $O^{16}(d, n)F^{17}$ produced by 8 MeV deuteron bombardment of a thin Pb peroxide target, were studied by means of photographic plates orientated at 5° intervals around the target. Two long-range neutron groups were found corresponding to transitions to the ground state and a $0{\cdot}53 \pm 0{\cdot}06$ MeV level in F^{17}. The theoretical interpretation of the observed angular distributions requires even parity for both states of F^{17} with spins of $\frac{3}{2}$ or $\frac{5}{2}$ for the ground state and $\frac{1}{2}$ for the excited state.

L. R. SHEPHERD

539.172.13

9697. The angular distribution of neutrons from the (*d*, *n*) reaction in light elements. J. HUGHES. *Proc. Phys. Soc., Lond. A*, **64**, 797–801 (*Sept.*, 1951).

A proton recoil chamber with a thick polythene layer was used to determine the angular distribution of the neutrons from thick targets of various light elements bombarded with 8 MeV deuterons. In all cases a pronounced forward maximum in intensity was found, the half width of the distribution decreasing with increasing atomic number. The absolute intensity of neutrons in the forward direction decreases as the atomic number increases but the dependence on atomic number is not a smooth function. Most elements show the presence of multiple forward peaks.

In a few elements the effect of reducing the incident deuteron energy was investigated. A.

539.172.13

9698. Deuteron bombardment of neon. R. Middleton and C. T. Tai. *Proc. Phys. Soc., Lond. A*, **64**, 801–7 (*Sept.*, 1951).

Ne gas of normal isotopic constitution was bombarded by 7·8 MeV deuterons from the Liverpool University cyclotron. Photographic plates were used as detectors, enabling the protons from the reactions $^{20}Ne(d, p)$ and $^{22}Ne(d, p)$ and alpha-particles from $^{20}Ne(d, \alpha)$ and $^{22}Ne(d, \alpha)$ to be studied, as well as a group of inelastically scattered deuterons. A.

539.172.13

9699. The lithium-7 nucleus. C. M. Class and S. S. Hanna. Letter in *Nature, Lond.*, **168**, 429 (*Sept.* 8, 1951).

Measurements of the angular correlation between the short-range proton and the γ-ray in the reaction $Li^6(d, p)Li^{7*}(\gamma)Li^7$ showed $< 3\%$ departure from spherical symmetry, in agreement with the assignment of $I = \frac{1}{2}$ to the Li^7 state involved. B. Rose

539.172.13

9700. The new state in Li^7 at low bombarding energy. R. W. Gelinas, C. M. Class and S. S. Hanna. Letter in *Phys. Rev.*, **83**, 1260 (*Sept.* 15, 1951).

Using 0·5 MeV deuterons, the new state [Abstr. 5740 (1951)] was located at $4·62 \pm 0·02$ MeV excitation by magnetic analysis of the $Be^9(d, \alpha)Li^7$ reaction. J. J. Wilkins

539.172.13

9701. The possibility of the reaction $H^3(d, p)H^4$. K. G. McNeill and W. Rall. Letter in *Phys. Rev.*, **83**, 1244 (*Sept.* 15, 1951).

An unsuccessful search for emitted protons and for H^4 β-decays is reported. J. J. Wilkins

539.172.3

9702. The reaction $B^{10}(\gamma, d)\,2He^4$. M. J. Brinkworth and E. W. Titterton. Letter in *Phil. Mag.*, **42**, 952–5 (*Aug.*, 1951).

Photographic plate studies of the energetics of the reaction $B^{10} + h\nu \rightarrow 2He^4 + H^2 - 5·89$ MeV suggest that the mode of disintegration is through Be^{8*} rather than Li^{6*}. W. J. Swiatecki

539.172.3

9703. A theoretical investigation of the photodisintegration of the alpha-particle. I. A. Gamba. *Nuovo Cim.*, **8**, 605–17 (*Sept.*, 1951).

A discussion of four-body problems in nuclear physics is given, using group theory and isotopic spin formalism. Since only the spin and isotopic spin dependence of the wave function is considered, and no assumption is made on nuclear forces, the treatment is meant to be of a very general character and may constitute the basis for any discussion of four-body problems. The fundamental state of the alpha-particle is discussed and it is found that it must be a mixture of three different types of functions, which are actually evaluated. To prepare the ground for a second paper, the final states $(D + D, H_3 + p, He_3 + n)$ are also dealt with. The electric dipole transition is introduced and some preliminary results in form of selection rules for the transition to the state D + D are given. A.

539.172.3

9704. The angular distribution in the photodisintegration of the deuteron at low energies. G. R. Bishop, L. E. Beghian and H. Halban. Letter in *Phys. Rev.*, **83**, 1052 (*Sept.* 1, 1951).

Enhanced accuracy was achieved by measuring the distribution in energy, rather than angle, of the photo-protons, using a deuterium filled proportional counter. Values of $0·247 \pm 0·007$, $0·360 \pm 0·008$ and $0·600 \pm 0·020$ are given for the ratio of photomagnetic to photoelectric cross-section, with Na^{24}, ThC″ and Ga^{72} sources respectively. J. J. Wilkins

539.172.3

9705. The photodisintegration cross-section of the deuteron. S. A. Colgate. Letter in *Phys. Rev.*, **83**, 1262–3 (*Sept.* 15, 1951).

A cross-section of $1·47 \pm 0·22$ mb for ThC″ gamma-rays was derived from total absorption measurements in H_2O and D_2O. J. J. Wilkins

539.172.3

9706. On the photonuclear dissociation of nuclei by the high energy gamma-rays. S. Kikuchi. Letter in *Phys. Rev.*, **83**, 1255–6 (*Sept.* 15, 1951).

Previous studies [Abstr. 2029 and 5768 (1951)] were extended to obtain the energy and angular distributions of emergent protons. The main conclusion drawn is that, for gamma-ray energies between 150 and 300 MeV, stars are produced mainly by formation and absorption of a meson inside the nucleus. J. J. Wilkins

539.172.3

9707. Photodisintegration of He^4. T. S. Benedict and W. M. Woodward. Letter in *Phys. Rev.*, **83**, 1269 (*Sept.* 15, 1951).

Using 300 MeV bremsstrahlung, the yield of 45 MeV to 120 MeV protons was measured at 60° and 90° laboratory angles. J. J. Wilkins

539.172.3

9708. Photoproton reactions in lead. A. G. W. Cameron, W. Harms and L. Katz. Letter in *Phys. Rev.*, **83**, 1264 (*Sept.* 15, 1951).

The combined Tl^{206} and Tl^{207} yield has been measured for gamma-ray energies up to 27 MeV. J. J. Wilkins

539.172.3

9709. The high energy nuclear photoeffect. J. S. Levinger. *Phys. Rev.*, **84**, 43–51 (*Oct.* 1, 1951).

The nuclear photoeffect for photons of energy greater than 150 MeV is calculated assuming the two-nucleon model used by Heidmann. The main features of the nuclear photoeffect are then quite similar to those of the deuteron photoeffect. The cross-section for nuclear absorption of a high energy photon is about 1·6A times the cross-section for the deuteron photoeffect. The deuteron photoeffect gives a very strongly forward angular distribution for protons of a

given energy, observed in the laboratory system. The angular distribution for protons from the nuclear photoeffect is almost as strongly forward: for 90-MeV protons in the laboratory system the ratio of the differential cross-section at 60° to that at 90° is about 3. The proton energy spectrum decreases rapidly with proton energy, and becomes steeper for observations at large angles. The calculated angular distributions and proton energy spectra are in fair agreement with measurements by Walker. The absolute value of the differential cross-section for 90-MeV protons from carbon at 30° (laboratory system) is about 0·2 μbarn/MeV steradian per Q, or about 20 μbarn/steradian per photon. This absolute value is about one-third the absolute value measured by Walker, and is somewhat larger than the absolute value measured by Levinthal and Silverman. A.

539.172.4

9710. Total cross sections of light nuclei for p, T-neutrons. C. K. Bockelman, D. W. Miller, R. K. Adair and H. H. Barschall. *Phys. Rev.*, **84,** 69–75 (*Oct.* 1, 1951).

The total cross-sections of Li, Be, B^{10}, B, C and O were measured for neutrons of energies between 1 and 3·3 MeV, Neutrons of about 20-keV energy spread were produced by bombarding a thin layer of Zr in which tritium had been absorbed with protons from the electrostatic generator. Resonances were observed in all nuclei except Li. In addition to well-defined levels, evidence was found for slow variations of the cross-sections with energy which might be explained by the presence of very wide levels in all these elements. A.

539.172.4

9711. Probable emission of a beryllium-8 nucleus in the fast neutron fission of thorium-232. E. W. Titterton. Letter in *Phys. Rev.*, **83,** 1076 (*Sept.* 1, 1951).

Tracks similar to Abstr. 1216 (1950) were observed, the two presumed α-tracks being inclined at 9° with energies of 10·0 and 9·6 MeV resp. The energy release (120 $\pm$ 10 keV) is somewhat higher than the measured value for the instability of Be^8 ground state. These events are very rare.

539.172.4

9712. Radiochemical studies on the fission of Th^{232} with pile neutrons. A. Turkevich and J. B. Niday. *Phys. Rev.*, **84,** 52–60 (*Oct.* 1, 1951).

The relative yields of more than 20 products in Th fission have been determined radiochemically. Pile neutrons with an estimated effective average energy of 2·6 MeV were used. The data have been used to construct a complete fission yield curve for Th^{232}. This is compared with the yield curves of other fissionable nuclei. Th fission is similar to the neutron fission of U^{235}, U^{233}, Pu^{239} and U^{238} in being highly asymmetric. With the neutrons used in this work the peak yields occur 110 times as frequently as symmetrical products. A.

539.172.4

9713. Energy distribution of fission fragments of U^{235} produced by 2·5-MeV and 14-MeV neutrons. S. S. Friedland. *Phys. Rev.*, **84,** 75–7 (*Oct.* 1, 1951).

The kinetic energy released in the fission of U^{235} by 2·5-MeV and 14-MeV neutrons has been measured. The results show the familiar two-peak curve when intensity of a fragment with a given energy is plotted against energy. However, the dip between the peaks apparently disappears with increasing energy of the neutrons and the distribution approaches a single symmetrical peak. A.

539.172.4 : 621.039.421(481)

9714. The Norwegian atomic reactor. *Tekn. Tidskr.*, **81,** 643–4 (*Aug.* 25, 1951) *In Swedish.*

An illustrated, detailed description of the 100 kW reactor, built in collaboration with Holland and made available for Norwegian and Dutch workers under equal conditions. The reactor uses 2·85 tons uranium with 7 000 l heavy water as moderator, and is intended as source of neutrons and radioactive isotopes, with a view to investigation of physical and chemical effects of neutron radiation on various materials.

J. A. WILCKEN

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

9715. Erratum. Absolute selection rules for meson decay. D. C. Peaslee. *Helv. Phys. Acta*, **24** (*No.* 3) 298 (1951). See Abstr. 3039 (1951).

539.18

9716. The multiple scattering of μ-mesons. A. V. Crewe. Letter in *Proc. Phys. Soc., Lond. A*, **64,** 660–1 (*July*, 1951).

Mesons in the energy limits 184 $\pm$ 12 MeV were selected by delayed coincidences. Their deviations were observed in a 1 in block of Pb, and the mean angle found to be 0·65$\times$ Williams theoretical value.

E. P. GEORGE

539.18

9717. On an alternative decay process for the neutral π-meson. R. H. Dalitz. Letter in *Proc. Phys. Soc., Lond. A*, **64,** 667–8 (*July*, 1951).

It is shown that the phenomenological representation of the 2 γ decay of the neutral π-meson implies further that about 1 in 80 π_0-mesons decay into a photon and an electron pair. R. H. DALITZ

539.18

9718. Experimental determination of the energy spectrum of electrons from μ-meson decay. A. Lagarrigue and C. Peyrou. *C.R. Acad. Sci., Paris*, **233,** 478–80 (*Aug.* 6, 1951) *In French.*

Energy measurements on 150 electrons from μ-meson decay in a cloud chamber are reported: the spectrum of decay electrons is examined in conjunction with earlier data (Leighton) and for possible differences between the spectrum of positive and negative electrons. J. G. WILSON

539.18

9719. Measurements of mass ratios in nuclear emulsions. S. von Friesen and K. Kristiansson. Letter in *Nature, Lond.*, **168,** 377 (*Sept.* 1, 1951).

Values varying between 1·6 and 2·1 are derived,

from track density measurements, for the π-meson/μ-meson mass ratio. J. J. WILKINS

539.18

9720. Density of tracks of protons and mesons in photographic emulsions. T. GUSTAFSON. Letter in *Nature, Lond.*, **168**, 377–8 (*Sept.* 1, 1951).

Possible explanations of Friesen and Kristiansson's results (preceding Abstr.) are discussed.

J. J. WILKINS

539.18

9721. Masses and modes of decay of heavy mesons. I. κ-Particles. C. O'CEALLAIGH. *Phil. Mag.*, **42**, 1032–9 (*Sept.*, 1951).

Observations by the photographic method are described which establish the existence of heavy charged mesons, of mass about 1 200 m_e, which decay with the emission of a single charged particle. In one case, it is shown that the secondary charged particle is a μ-meson of energy 5·9 MeV. In another, it is a particle of charge $|e|$ and of energy about 200 MeV. If the two particles are of the same type with similar modes of decay, then the charged secondary particle must be accompanied by at least two neutral particles. The question whether the κ-particles are identical with the τ-mesons which decay into three charged particles, is discussed. A.

539.18

9722. Masses and modes of decay of heavy mesons. II. τ-Particles. P. H. FOWLER, M. G. K. MENON, C. F. POWELL AND O. ROCHAT. *Phil. Mag.*, **42**, 1040–9 (*Sept.*, 1951).

Further evidence which establishes the existence of heavy charged mesons which decay into three charged particles is presented. It is shown that the three secondary particles are probably π-particles, and that the mass of the parent mesons, called τ-particles, is $966 \pm 8\ m_e$. The frequency of occurrence of κ- and τ-particles at the Jungfraujoch, in comparison with the number of π-particles, is discussed, and it is shown that in the nuclear collisions involving protons of energy greater than 10 BeV, a large fraction of the energy lost in the creation of mesons, must appear as κ- and τ-particles. The evidence suggests that the life-time of the heavy mesons is about 10^{-9} sec. The most favourable conditions for the detection of the particles by the photographic method are discussed. A.

539.18

9723. Absorption of slow μ-mesons in nuclear emulsions. A. BONETTI AND G. TOMASINI. *Nuovo Cim.*, **8**, 693–704 (*Sept.*, 1951).

380 cm² of 600 μ Ilford G5 plates and 200 cm² of 400 μ Ilford G5 plates have been scanned, and 1 004 tracks of mesons which stopped in the interior of the emulsion have been observed. The plates were exposed vertically during 6 days at 2 900 m above sea level (Pic du Midi), far from heavy materials. The determination has been made of: (*a*) the fraction of μ-mesons which undergo β-decay; (*b*) the number of slow electrons associated with the capture of μ-mesons; (*c*) the energy distribution of the slow electrons. A.

539.18

9724. π^- absorption in D_2 and the $n-n$ force. R. L. AAMODT, W. K. H. PANOFSKY AND R. PHILLIPS. Letter in *Phys. Rev.*, **83**, 1057 (*Sept.* 1, 1951).

Experimental data on the gamma-ray spectra from $\pi^- + d \rightarrow 2n + \gamma$ and $\pi^- + p \rightarrow n + \gamma$ are given. The data yield probabilities of 25% and 10% for di-neutron binding energies in excess of 10 keV and 150 keV respectively. J. J. WILKINS

539.18

9725. Nuclear absorption of negative pi-mesons at different energies. G. BERNARDINI, E. T. BOOTH AND L. LEDERMAN. Letter in *Phys. Rev.*, **83**, 1075 (*Sept.* 1, 1951).

The mean free path in G5 nuclear emulsion has been determined at energies from 30 to 110 MeV for stars, stops, elastic scattering and inelastic scattering. At high energies the m.f.p. is close to the geometric value, at low energies a transparency of 30% is reported. E. P. GEORGE

539.181

9726. Molecular diffraction under high vacuum. B. MISHRA. Letter in *Curr. Sci.*, **20**, 177 (*July*, 1951).

Paraffin, evaporated through an aperture in a vacuum, gives patterns that are said to arise from molecular diffraction. J. THEWLIS

539.185

9727. The scattering of neutrons by bound protons and crystals. H. H. CLAYTON. *Nat. Res. Coun. Can., Publ., No.* 2393, 70 *pp.* (1947).

A lecture course discussing the relation of the coherent and incoherent scattering of neutrons by protons in chemical compounds and by crystals to the elastic scattering by the free particles. Treatments follow Fermi [*Ric. Sci.*, **7**, 13–52 (*July*, 1936)] and Weinstock [Abstr. 1161 (1944)] respectively.

R. H. DALITZ

539.185

9728. Detection of slow neutrons. B. W. SARGENT. *Nat. Res. Coun. Can., Publ., No.* 2397, 45 *pp.* (1950).

A general survey based on a course of two lectures. The reaction $B^{10}(n, \alpha)Li^7$ is considered in detail and the construction of B chambers is described. The $He^3(n, p)H^3$ reaction is also considered and its advantages over the B reaction discussed. Fission chambers and foil detectors are also treated. The $1/v$ law is discussed and exceptions considered, an outline being given of the facts and theories concerning the resonance capture of neutrons. Finally, consideration is given to the comparison of fast neutron sources by the detection of slowed down neutrons arising from these sources. J. THEWLIS

539.185

9729. Slow-neutron detection by foils. II. C. W. TITTLE. *Nucleonics*, **9**, 60–7 (*July*, 1951).

For Pt I, see Abstr. 8231 (1951). Two corrections which must be made in In foil measurements of neutron density, are considered. The first is due to the absorption of In resonance neutrons by the Cd cover; the second correction allows for the depression

of the thermal neutron flux in the medium, due to the presence of the detecting foil. It is shown that Bothe's formula for the latter correction is in good agreement with experimental values provided that the transport m.f.p. is substituted for scattering m.f.p.

L. R. SHEPHERD

539.185

9730. Neutron resonances of tellurium. C. HEINDL AND I. W. RUDERMAN. Letter in *Phys. Rev.*, **83**, 660 (*Aug.* 1, 1951).

The total cross-section of tellurium has been measured in the 0·06–2 000 eV range. A resonance at 2·2 eV is ascribed to Te^{123}, by studies of the enriched isotopes. B. ROSE

539.185

9731. Inelastic scattering of cold neutrons. P. A. EGELSTAFF. Letter in *Nature, Lond.*, **168**, 290 (*Aug.* 18, 1951).

Investigates the gain of energy of cold neutrons (mean energy 0·0017 eV, maximum 0·0026 eV) on being scattered by crystalline materials. Estimates are given of the relative amounts of inelastic and disordered scattering. J. THEWLIS

539.185

9732. Li^9—new delayed neutron emitter. W. L. GARDNER, N. KNABLE AND B. J. MOYER. Letter in *Phys. Rev.*, **83**, 1054 (*Sept.* 1, 1951).

A delayed neutron activity with ½-life of 0·168 ± 0·004 sec was obtained from the deuteron bombardment of Be, B (cross-section ~ 4 barns), C and N, and the proton bombardment of B, C and N. The activity is assigned to $Li^9 \rightarrow \beta^- + Be^{9*} \rightarrow Be^9 + n$, and the reactions are e.g. $Be^9(d, 2p)Li^9$ and $B^{11}(p, 3p)Li^9$. The exptl. threshold for $Be^9(d, 2p)Li^9$ is 19 ± 1 MeV, in agreement with that estimated from the mass of Li^9. A. O. STANESBY

539.185

9733. Magnetic neutron diffraction from exchange-coupled lattices at high temperatures. M. SLOTNICK. *Phys. Rev.*, **83**, 1226–30 (*Sept.* 15, 1951).

The magnetic scattering of slow neutrons from a crystal lattice with exchange coupling at temperatures much higher than the (ferromagnetic or antiferromagnetic) Curie point is investigated. The residual short-range order is shown to manifest itself in coherent and inelastic effects, which are calculated by means of an expansion in $1/T$. These effects can yield information on the strength of the exchange interactions, the ratio of nearest neighbour to next nearest neighbour interactions, etc. Conditions for the observability of these effects are more favourable in the antiferromagnetic case. A.

539.185 : 548.7

9734. The scattering of neutrons by crystals. J. M. CASSELS. *Progress in Nuclear Physics*, 1. *London, Butterworth–Springer; New York, Academic Press* (1950) 185–215.

The scattering by a single nucleus is first considered, for nuclei with and without spin. These calculations are then applied to a polycrystalline sample, taking in succession the cases of several isotopes, nuclei with spin, and finite mass of the nucleus, introducing inelastic scattering; assistance in computing the latter may be obtained from graphs presented in this section. Attention is devoted to scattering of mixed crystals containing more than one element. In the last section, experimental investigations are considered: (*a*) determination of the scattering constants of elements; (*b*) variations of inelastic scattering with temperature; (*c*) determination of crystal structure and such problems as order-disorder transitions in alloys. (Bibliography of 31 refs.)

539.185.7

9735. Slow neutron velocity spectrometer studies. IV. Au, Ag, Br, Fe, Co, Ni, Zn. W. W. HAVENS, JR, AND L. J. RAINWATER. *Phys. Rev.*, **83**, 1123–33 (*Sept.* 15, 1951).

For Pt III, see Abstr. 1319 (1947). See also Abstr. 2592, 2594 (1948). The spectrometer has been improved, enlarged and all the operational factors re-evaluated. The principal resonance in Au has been redetermined as $E_0 = 4{\cdot}87 \pm 0{\cdot}07$ eV, and in Ag as $5{\cdot}13 \pm 0{\cdot}07$ eV. Resonances are found in Br at 35·7, 54, 104 and 136 eV. Transmission dips are also observed at higher energies which are probably due to unresolved levels. The thermal cross-section of Fe is well matched by the relation $\sigma = (11{\cdot}2 + 0{\cdot}33E^{-\frac{1}{2}})$. Crystal interference effects are observed in the thermal region with the Debye–Scherrer rings at 2·3 Å and 2·8 Å resolved. The cut-off wavelength predicted to be at 4·04 Å is in good agreement with experiment. No strong resonances are observed in Fe at high energies. Resonances are observed in Co at 126 eV and 5 000 eV. Ni shows crystal interference effects in the thermal region. No strong resonances were detected at high energies. The thermal cross-section of Zn is well matched by the relation $\sigma = 3{\cdot}85 + 0{\cdot}14E^{-\frac{1}{2}}$ with crystal interferences effects observed in the thermal region. Resonances in Zn occur at 520 eV, 1 100 eV and 3 800 eV. A.

539.185.9 : 541.15

Szilard–Chalmers effect with slow and fast neutrons. *See Abstr.* 9779

STRUCTURE OF SOLIDS 539.2

539.211 : 548.73

9736. Atomic arrangements in gold–nickel solid solutions. P. A. FLINN AND B. L. AVERBACH. Letter in *Phys. Rev.*, **83**, 1070 (*Sept.* 1, 1951).

The diffuse low angle X-ray scattering to be expected from Au–Ni solid solutions containing Ni rich and Au rich clusters, which a study of the equilibrium diagram and thermodynamic properties suggests might exist in such alloys above 840°c, was not observed experimentally nor were the observations interpretable in terms of local order. A. D. LE CLAIRE

539.215.4

9737. Particle agglomeration in tungsten metal powder. B. KOPELMAN AND C. C. GREGG. *J. Phys. Coll. Chem.*, **55**, 557–63 (*April*, 1951).

Discrepancies occur in the particle size analysis of tungsten powders between sedimentation and micro-

scopic determinations and the effect of agglomeration is investigated in the present paper. Sedimentation analysis with the aid of a photelometer has been used to study how the agglomeration depends on the dielectric constant of the dispensing medium and it has been found that liquids with a dielectric constant greater than 25 do not cause any flocculation. By extrapolation it has been shown that a powder with average particle size 4·2 microns would appear to have a particle size of 10 microns when dispersed in air. J. M. HOUGH

539.215.4 : 532.5

9738. The physics of particle size measurement. I. Fluid dynamics and the Stokes diameter. P. G. W. HAWSLEY. *B.C.U.R.A. Bull.*, **15**, 105–42 (*April*, 1951).

A comprehensive review of the fundamental physics involved in the different methods and also a discussion of what is understood by the size of an irregular particle. A new diameter, the drag diameter, is defined as the diameter of a sphere having the same resistance to motion as the particle in a fluid of the same viscosity and at the same velocity. This portion of the review gives a summary of the dynamics of particles in fluids and then applies this information to a critical examination of some of the problems of sedimentation, elutriation, etc. Finally, the flow of fluids through beds and its application to permeability measurements is discussed. J. M. HOUGH

539.217

9739. Studies on tellurium-selenium alloys. E. GRISON. *J. Chem. Phys.*, **19**, 1109–13 (*Sept.*, 1951).

Te and metallic (hexagonal) Se were shown to give solid solution in any concentration. The variation of the cell dimensions with composition departs only slightly from linearity: c shows a certain tendency to contraction (this corresponds to a smaller valency angle in the chains of atoms than is required by a linear variation): a varies much less (2% between Se and Te) and in a manner which depends upon the preparation of the alloy (as already observed for pure Se by H. Krebs). The presence of sharp ($hk.l$) lines with $l \neq 0$ in all the alloys suggests that these must be composed not of homogeneous chains (i.e., Se chains, Te chains packed together), but of composite chains, in which the homogeneous sequences must be fairly short. A.

539.217

9740. A reinterpretation of experiments on intermetallic diffusion. A. S. NOWICK. *J. Appl. Phys.*, **22**, 1182–6 (*Sept.*, 1951).

Reported values for the heat of activation, H, for volume chemical diffusion, as obtained from the slope of the best straight line in a semi-logarithmic plot of diffusion data against T^{-1}, may often be greatly in error. These values will be too low whenever diffusion along internal surfaces plays a significant role at the lower temperatures of measurement. A method is presented which attempts to avoid such errors in H by using the calculated values of Zener for the intercept of the straight line. When the data is reconsidered in the light of this method, the widely accepted belief, that H for chemical diffusion in dilute solid solutions is generally considerably less than H for self-diffusion of the solvent, is brought to question. In fact, it is found that the chemical diffusion activation energy is generally within 15% of that for self-diffusion. It is further concluded that the process of diffusion under a chemical gradient may itself produce internal surfaces which act as short-circuiting diffusion paths. A.

539.234 : 541.182.6

9741. Orientation effects in transparent alumina films. W. O. MULLIGAN AND H. B. WEISER. *J. Phys. Coll. Chem.*, **55**, 490–6 (*April*, 1951).

Transparent films of alumina ($\gamma . Al_2O_3 . H_2O$ or γ . AlOOH) were made by evaporating a highly thixotropic alumina sol to dryness at room temperature. Electron diffraction examination of thin films and X-ray examination of thick films showed in both cases that the γ . AlOOH crystals were oriented. On heating to 600–800°C to produce $\gamma . Al_2O_3$, the films remained transparent and continued to show an orientation, suggesting a close relation between the structures of $\gamma . Al_2O_3$ and γ . AlOOH. The films cracked at the edges when formed on a relatively rigid surface and curled or puckered when formed on a Hg surface, suggesting that the orientation process is closely connected with the strains resulting from the drying of the gel.

A. D. LE CLAIRE

539.27 : 539.23

9742. A study of oxide films formed on copper-magnesium alloys by electron diffraction. H. TAZAKI AND S. KUWABARA. *J. Sci. Hiroshima Univ. Ser. A*, **15**, 67–70 (*March*, 1951).

Cu–Mg alloys containing up to 10% Mg were heated in quartz tubes, and the effect of varying temperature, air pressure and heating time on the surface oxide films investigated by electron diffraction.

M. R. HOPKINS

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.31

9743. The elasticity of porous media. F. GASSMANN. *Mitt. Inst. Geophys. E.T.H. Zürich*, *No.* 17, 23 *pp.* (1951) *In German.*

Differential elasticity is defined in terms of increments of stress and strain, the moduli depending on the average strain. The elasticity of the porous medium is described in terms of the elastic properties of the frame and those of the medium filling the pores with suitable simplifying assumptions. The results are generalized for an anisotropic frame.

J. E. CAFFYN

539.31

9744. On the stress-function approaches of Boussinesq and Timpe to the axisymmetric problem of elasticity theory. E. STERNBERG, R. A. EUBANKS AND M. A. SADOWSKY. *J. Appl. Phys.*, **22**, 1121–4 (*Sept.*, 1951).

In the first part of this note the stress-function approaches are referred to general orthogonal

axisymmetric curvilinear co-ordinates. In the second part a connection between the two stress-function approaches is established. A.

539.32.08

9745. A recording torsion pendulum for the measurement of the dynamic mechanical properties of plastics and rubbers. L. E. NIELSEN. *Rev. Sci. Instrum.*, **22**, 690–3 (*Sept.*, 1951).

The mechanical oscillations are converted into electrical potentials for recording by a torque measuring device which is actuated by a differential transformer. The apparatus is capable of measuring the modulus and damping of materials over an extremely wide range. A.

539.37

9746. Mechanical properties of α-solid solutions of copper, with zinc, gallium, germanium and arsenic. N. P. ALLEN, T. H. SCHOFIELD AND A. E. L. TATE. Letter in *Nature, Lond.*, **168**, 378–9 (*Sept.* 1, 1951).

The ultimate tensile strength, the resistance to plastic deformation and perhaps also the 0·5% proof stress of these alloys appears to be almost entirely governed by their electron–atom ratio.

A. D. LE CLAIRE

539.371

9747. Finite extension and torsion of cylinders. A. E. GREEN AND R. T. SHIELD. *Philos. Trans A*, **244** (*No.* 876) 47–86 (1951).

The theory of finite elastic deformations of an isotropic body, in which a completely general strain-energy function is used, is applied to the problem of a small twist superposed upon a finite extension of a cylinder which has a constant cross-section. The law which relates the force necessary to produce the large extension, with the torsional modulus for the small torsion superposed on that extension, is given by a simple general formula. The problems of a small twist superposed upon a hydrostatic pressure, or upon a combined hydrostatic pressure and tension, are also solved. Attention is then confined to isotropic incompressible rubber-like materials using a strain-energy function suggested by Mooney, and the second-order effects which accompany the torsion of cylinders of constant cross-sections are examined. A.

539.373

9748. The mechanical properties of metals. N. F. MOTT. *Proc. Phys. Soc., Lond. B*, **64**, 729–41 (*Sept.*, 1951).

A description is given of edge and screw dislocations in a close-packed cubic lattice, which leads up to an account of the theory of Frank and Read of the origin of slip bands. Consideration is then given to a crystalline grain containing Frank–Read sources; it is shown that one has to expect cross-slip and the formation of deformation bands. It is shown moreover that the formation of vacancies by moving dislocations plays an essential role in these processes. Some speculations on the stability of deformation bands are given. It is suggested that the movement of vacancies (self-diffusion) plays an essential part in polygonization, recovery and steady-state creep, enabling dislocations in deformation bands to move out of their slip planes and so relieve stress. It is probable moreover that in these bands the stresses are several hundred times greater than the applied stress, and that this enables diffusion to occur at temperatures at which it would not be possible otherwise. Finally an account is given of low temperature creep of the type which does not involve recovery. A.

539.373

9749. The deformation and ageing of mild steel. II. Characteristics of the Lüders deformation. E. O. HALL. *Proc. Phys. Soc., Lond. B*, **64**, 742–7 (*Sept.*, 1951).

For Pt I, see Abstr. 6510 (1951). Some of the factors which influence the appearance of Lüders bands in mild steel are studied. It is shown that the Lüders band is adequately described by a uniform shear front, spreading over the specimen. In coarse-grained specimens, experiments indicate that this front becomes diffuse; diffuse bands are also present in strain-aged material, but here the diffuse fronts become sharper as the ageing becomes progressively longer. A.

539.373

9750. The deformation and ageing of mild steel. III. Discussion of results. E. O. HALL. *Proc. Phys. Soc., Lond. B*, **64**, 747–53 (*Sept.*, 1951).

An attempt is made here to explain the observed phenomena in the yielding and ageing of mild steel, described the preceding parts, in the general terms of a grain-boundary theory. On this hypothesis, a satisfactory explanation of the variation of the lower yield point with grain size may be developed. It is shown that strain-ageing must involve two processes: a healing of the grain-boundary films, coupled with a hardening in the grains themselves. A discussion of the possible nature of the grain-boundary film is also undertaken. A.

539.374 : 536.7

9751. Contribution to the thermodynamics of plastic deformation. N. S. FASTOV. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 2) 251–4 (1951) *In Russian.*

Kachanov's equation [Abstr. 2606 (1948)] developed for an infinitely slow deformation process is transformed mathematically into an expression for the free energy of a body whose deformation goes on at a finite velocity. It is claimed that equations obtained ultimately for (1) the relationship between the fluidity limit and the maximum elastic deformation on the one side and the velocity of deformation on the other side; and (2) the relationship between stresses, and the amount of deformation and the velocity of plastic deformation, as well as the appearance of the creep curve, qualitatively agree with experimental data. F. LACHMAN

539.374 : 548.0

9752. The development of deformation textures in metals. III. Hexagonal structures. E. A. CALNAN AND C. J. B. CLEWS. *Phil. Mag.*, **42**. 919–31 (*Aug.*, 1951).

The extension of the treatment set out in Parts I and II [Abstr. 1373 and 9030 (1951)] to the problem

of twinning, and its application to deformation textures in hexagonal metals. The geometry of twinning for the two cases where the axial ratio c/a is $>$ or $<\sqrt{3}$ is set out, and the equation to the boundary between regions of slip and twinning, for tension and compression, obtained by equating the ratio resolved/critical shear stress for slip to the ratio for twinning. It is assumed that the critical shear stresses for slip equal that for twinning, this assumption being critically examined. Tension, compression and rolling textures are derived for Mg and Zn (representing the two cases of the c/a value) which agree well with those observed. It is claimed that the method can be refined to take account of pyramidal slip, or for particular problems. A. J. KENNEDY

539.389.3

9753. Relaxation spectrum from rubber. B. GROSS. *Rep. Brit. Elect. Res. Ass.* (*Ref. L/T234*) 4 *pp.* (1950).

A method for its determination from creep data given by W. Kuhn *et al.* is discussed. It is shown that no mathematically satisfactory theory can be formulated which does not make allowance for a finite instantaneous deformation (strain) after instantaneous loading. A.

539.6

9754. The reinforcement of rubber by carbon black. D. PARKINSON. *Brit. J. Appl. Phys.*, **2**, 273–80 (*Oct.*, 1951).

Recent research on the carbon reinforcement of rubber is reviewed and existing theories examined. The stiffening effect of carbon black is thought to be little influenced by the size of the individual spherical particles, but values of tensile strength, tear strength and abrasion resistance increase with decreasing particle size of the black. Departures from this generalization are considered and possible factors discussed. The nature of the attachments between carbon particles and rubber molecules forms the subject of much current research, the results of some of which indicate the possibility that chemical cross linkages supplement physical adsorption at the carbon-rubber interface. A.

539.89

9755. Some experimental indications of the stresses produced in a body by an exploding charge. J. S. RINEHART. *J. Appl. Phys.*, **22**, 1178–81 (*Sept.*, 1951).

The effects produced by small cylindrical charges that were detonated on the surfaces of heavy steel plates are discussed. Particular attention is paid to (*a*) shapes of crater, (*b*) changes in hardness, (*c*) flow patterns, (*d*) fractures, and (*e*) changes in microstructure. The distribution of stress appears in some respects to correspond to that which might be set up by a static load. The mechanisms of the inelastic deformation, however, differ very greatly between the static case and the dynamic case. Dynamic loading produces numerous shock twins and fractures that undoubtedly occur because of the very high strain rates involved. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.2

9756. Two-phase equilibrium in binary and ternary systems. V. Carbon dioxide–ethylene. VI. Carbon dioxide–propylene. G. G. HASELDEN, D. M. NEWITT AND S. M. SHAH. *Proc. Roy. Soc. A*, **209**, 1–14 (*Oct.* 8, 1951).

For Pt IV, see Abstr. 2122 (1941). The pressure-temperature-composition data for liquid-vapour equilibrium in the systems carbon dioxide–ethylene and carbon dioxide–propylene are given; the former system is shown to form a series of azeotropes. The plait-point curves and critical constants for the two series of mixtures have been determined. A.

541.123.2

9757. Two-phase equilibrium in binary and ternary systems. VII. Calculation of latent heats and some other similar properties. R. F. STRICKLAND-CONSTABLE. *Proc. Roy. Soc. A*, **209**, 14–27 (*Oct.* 8, 1951).

Exact thermodynamic expressions are derived for the principal latent heats of binary mixtures, which enable these quantities to be calculated in terms of other properties. These expressions are in each case the sum of two terms, which are designated the "direct" and the "indirect" terms respectively. Calculation of the latent heats of the first and last drops is only a special case of the more general calculation of the latent heat of any drop. To carry out this calculation it is first of all necessary to obtain a general expression for the total change in entropy when any drop is distilled, in terms of the composition of the drop and of the properties of the phases. It is also necessary to find an expression for the composition of the drop in terms of the changes in composition of the phases. Combining all these results it is possible to obtain expressions for the various latent heats of any drop in terms of the equilibrium phase data, and of the properties and masses of the individual phases. Three of these latent heats are treated in detail. Exact integral latent heats are obtained by the integration of the differential latent heats. A numerical example is worked out. The general method of calculation has also been applied to the evaluation of the Joule–Thomson coefficient in the two-phase region of a binary system. A.

541.123.2/.3

9758. Two-phase equilibrium in binary and ternary systems. VIII. The integral flash latent heat at constant pressure of the system ethylene–carbon dioxide. A. J. BARNARD, S. P. LUTHRA, D. M. NEWITT AND M. U. PAI. *Proc. Roy. Soc. A*, **209**, 143–57 (*Oct.* 23, 1951).

For Pt VII, see Abstr. 9757 (1951). A method of

determining the integral flash latent heat of a binary mixture at constant pressure is described and results are given for the system ethylene–carbon dioxide. The experimental results are compared with those calculated from the Duhem–Margules equation. A.

541.123.5

9759. Determination of sorbed water by exchange with deuterium oxide. Extension of the exchange method to the study of macromolecular structures. R. VIALLARD, Letter in *J. Chim. Phys.*, **48**, 372 (1951) *In French.*

Such exchange occurs if the substance is immersed in a large excess of heavy water of high D_2O content. Density measurements then enable the amount of D_2O present in the heavy water to be determined and, if the constitution of the substance is known, the degree of hydration is obtainable. The rate at which the exchange occurs can be used to study the internal structure of the substance. J. GRANT

541.124

9760. Action of hot ionized gases upon zirconium and copper. A. DRAVNIEKS. *J. Phys. Coll. Chem.*, **55**, 540–9 (*April*, 1951).

Relative reaction rates of Zr at 986° and Cu at 750°c with low-pressure non-ionized and ionized O, air, H_2O (vapour), CO_2, CO, N (with 0·5% O), CH_4 and technical He were studied by measuring changes in electrical resistance. The ionization caused in some cases an acceleration, in others a retardation of the reaction between Zr and the gas. The oxidation in H_2O was abnormally fast. The ionization of CO_2 caused a slow oxidation of Cu, proceeding according to a parabolic law. F. LACHMAN

541.124

9761. The thermal oxidation of methylamine. C. F. CULLIS AND J. P. WILLSHER. *Proc. Roy. Soc. A*, **209**, 218–38 (*Oct.* 23, 1951).

541.124 : 530.145

9762. The quantum mechanics of chemical kinetics of homogeneous gas-phase reactions. III. A collision model approximation for intramolecular rearrangements. S. GOLDEN AND A. M. PEISER. *J. Phys. Coll. Chem.*, **55**, 789–81 (*June*, 1951).

See Abstr. 6487 (1949). The chemical kinetics of intramolecular rearrangements has been considered. Use is made of a model that assumes "hard collisions" between a reacting system and its surroundings. The role of collisions is assumed to be twofold: (1) immediately after a collision the reacting system is to be found in one of the quasi-stationary states of the reactants if no chemical transition has occurred; (2) if a chemical transition has occurred the reacting system is to be found, immediately following a collision, in one of the quasi-stationary states of the products. In both cases the probability distribution among the various states is assumed to be that corresponding to thermal equilibrium. This mechanism of "hard collisions" makes it possible to refer to quasi-stationary wave functions of the reacting system immediately following a collision. It provides, also, a means of conserving the total energy and the translational momentum of a reacting system when this would not be the case for the isolated system. A.

541.126

9763. Observation of cool flames with ethylene. J. R. ABBOTT AND S. A. MILLER. Letter in *Nature, Lond.*, **168**, 474–5 (*Sept.* 15, 1951).

Two types of flame were observed on spontaneous ignition of $C_2H_4/O_2/N_2$ mixtures containing 5–6% O_2 and 15–68% C_2H_4 at 300°c and approx. 20–40 atm. At low pressures the flame was pale blue, travelling at approx. 1 cm/sec and its passage was accompanied by peroxide formation; at higher pressures the flame was bright red, travelled at >50 cm/sec, no peroxides being formed. The transition between the 2 types of flame occupies a pressure region 2–3 atm. wide within which two-stage ignition sometimes occurs. Non-occurrence of cool flames in earlier expts. [*Proc. Roy. Soc. A*, **160**, 174 (1937)] suggests that the greater quantity of N_2 used as a diluent in the present work is a vital factor in the formation of cool flames in C_2H_4. A. SCHOFIELD

541.126 : 536.461

9764. The theory of flame propagation. II. J. O. HIRSCHFELDER AND C. F. CURTISS. *J. Phys. Coll. Chem.*, **55**, 774–88 (*June*, 1951).

For Pt I, see Abstr. 2487 (1950).

541.127

9765. The mechanism of bimolecular reactions in solutions. J. A. CHRISTIANSEN. *J. Coll. Sci.*, **6**, 213–18 (*June*, 1951).

A mathematical proof is given for the statement that the intermediate case (when the reciprocal velocity of "intramolecular" diffusion is of the same order of magnitude as that of the chemical reaction proper) occurs only very exceptionally, whereas in both extreme cases the overall velocity obeys the Arrhenius equation. In the case of very fast reactions Debye's collision probability must be used, while in the case of reactions with a considerable heat of activation the ordinary collision number must be applied. F. LACHMAN

541.127

9766. Acceleration of certain chemical reactions under the action of an electric field. J. LIMA-DE-FARIA. *C.R. Acad. Sci., Paris*, **233**, 252–4 (*July* 16, 1951) *In French.*

Experiments are recorded with apparatus already described [Abstr. 6531 (1951)] on the rates of chemical reactions which take place under the influence of an electric field, and which exhibit accelerations over the rates when the field is absent. The reactions recorded are: $FeSO_4 + (NH_4)_2S$, $H_2SO_4 + BaCl_2$, $K_4Fe(CN)_6 + FeCl_2$ and $K_4Fe(CN)_6 + FeCl_3$. For confirmation, $Pb(NO_3)_2$ and NaI are reacted under a field of 220 V at concentrations where no interaction occurs normally, to give PbI_2. Similar results are obtained with $HCl + KMnO_4$ and $Pb(NO_3)_2 + KBr$. Applications of this phenomenon are envisaged for increasing the sensitivity of certain characteristic reactions in qualitative analysis, and for the study of catalysis. H. H. HODGSON

541.127 : 539.132

9767. Some recent theories of chemical reactivity. C. A. COULSON. *Research, Lond.*, **4**, 307–14 (*July*, 1951).

In following the reaction path it is helpful to dis-

tinguish 4 phases: (i) the initial state, (ii) the polarized one, (iii) the transition state, (iv) the final one. Calculations of π-electron distribution, bond energies and self-polarizability define stages (ii) and (iii) well enough to determine relative reaction rates. Steric and entropy effects are not yet embraced by these molecular orbital considerations. J. JACOBS

ELECTROCHEMISTRY 541.13

541.135.2

9768. The possibilities of extracting the hydrogen ion from electrolytic solutions. L.-H. COLLET. Letter in *J. Phys. Radium*, **12**, 697 (*June*, 1951) *In French.*

Darmois' hypothesis [Abstr. 2130 (1951)] of a semi-free state for the hydrogen ion in solution comparable with that of an electron in a metal is discussed, together with the possibilities of its extraction, (*a*) by bombardment of the solution with particles of sufficient energy, and (*b*) by absorption of radiation of suitable wavelength. H. H. HODGSON

541.135.2

9769. Space charge in electrolytes during electrolysis. C. W. TOBIAS. Letter in *J. Chem. Phys.*, **19**, 1211–12 (*Sept.*, 1951).

It is pointed out that in Schriever and Ferguson's recent paper [see Abstr. 5864 (1951)] on the $Pt/KCl_{(aq)}/Pt$ system, certain physico-chemical facts, now noted, do not appear to have been taken into account; e.g. their space-charge calculation method necessitates the wrong assumption that the conductivity was constant throughout the cell, and that the potential of the reference electrode was independent of its position. Also, that these authors' claim of reproducibility of results is offset by the generous number of correction terms applied to the potential data. 6 refs. H. H. HODGSON

541.135.2

9770. Space charge in electrolytes during electrolysis: a reply. W. SCHRIEVER. Letter in *J. Chem. Phys.*, **19**, 1212 (*Sept.*, 1951).

In reply to Tobias (see preceding Abstr.), the necessity to assume constant conductivity throughout the cell in making the space-charge calculations is denied; it is claimed, however, that the conductivity was found to be constant in the region under investigation. The three corrections referred to as generous are shown to be actual measured values fully explained in the publications (3 refs.), and not estimates concocted to make data fit a preconceived idea.

H. H. HODGSON

541.135.2 : 669.22 : 621.357.1

9771. Periodic oscillations obtained during the anodic dissolution of silver. C. CHALIN. *C.R. Acad. Sci., Paris*, **233**, 362–4 (*July* 30, 1951) *In French.*

Results are given for the working of an electrolytic cell having a Ag wire 1 mm diameter and 0·45 in. in length as anode and a Pt cathode, both immersed in an aq. solution of KCN (1 g) : H_2O (17 g). Curves are given for current variation, cell resistance and modulus of impedance, as a function of voltage at the cell terminals. The curves have been drawn both for increasing and decreasing voltage. The current/voltage curve indicates an unstable region where the anode is covered with a brown translucent layer, and a step, followed by a fall, where the anode has an adherent greyish-black deposit. The resistance-voltage curve shows no maximum, which may be explained by anodic deposit formation, and the impedance-voltage curve presents a discontinuity for the unstable region. These results are only obtained at increasing voltages. The periodicity occurs in the unstable region, i.e. where electrolytic polishing can occur, and the optimum conditions for the latter can only be realized for an intermediate zone between the two characteristic values of current/voltage where the periodic oscillations occur. H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

9772. Decomposition of hydrogen peroxide by high energy X-rays. E. R. JOHNSON. Letter in *J. Chem. Phys.*, **19**, 1204–5 (*Sept.*, 1951).

The decomposition of air-free unbuffered H_2O_2 solutions by X-rays from a 2 MeV Van de Graaff generator is studied over the concentration range 1×10^{-4} to $12{\cdot}4\times10^{-3}$ M at intensities from 3 to 38·7 r/sec. Curves relating to decomposition of H_2O_2 as a function of initial concentration, hydrogen yield against dose, and decomposition of H_2O_2 against dose rate are given. C. B. ALLSOPP

541.15

9773. Decomposition of water by alpha radiation. M. LEFORT. *J. Chim. Phys.*, **48**, 339–43 (1951) *In French.*

The formation of hydrogen peroxide, oxygen and hydrogen during the irradiation of water with α-rays from radon has been studied quantitatively. The results suggest that the water is not decomposed into hydrogen and oxygen as in electrolysis, but rather into OH and H radicals capable of immediate inter-reaction to form hydrogen peroxide and hydrogen.

C. B. ALLSOPP

541.15

9774. Chemical effects of the bombardment of pyridine oxalate with neutrons. G. GIACOMELLO. Letter in *Ric. Sci.*, **21**, 1211–12 (*July*, 1951) *In Italian.*

The oxalate was bombarded with neutrons from the B.E.P.O. atomic pile in a quartz tube, in a current of CO_2 which was subsequently absorbed in 2 wash-bottles in series containing aq. $Ba(OH)_2$. The resulting $BaCO_3$ was radioactive to the extent of approx. 1·2 and 0·7% of the total radioactivity, respectively. CO, CO_2, C_6H_6 and C_6H_5. OH were identified in the tube after irradiation, and their radioactivities together totalled approx. 15% of that due to the C^{14}.

J. GRANT

541.15

9775. Radiation chemistry. *Brit. J. Radiol.*, **24**, 413–40 (*Aug.*, 1951).

One of four related symposia on the Biological Effects of Radiations held at the International Congress of Radiology, London, 1950.

I. Radiation chemistry in relation to radiobiology. C. B. ALLSOPP (413–16). The principal developments in radiation chemistry since 1937 are reviewed. The limitations of the target theory of the biological effects are outlined and the requirements of a chemical theory which would supplement and include the target theory are indicated.

II. Elementary processes in the radiation chemistry of water and implications for radiobiology. M. BURTON (416–22). The effects of radiations on pure water, on water containing oxygen, on organic material and on organic suspensions in water are described and discussed in terms of the formation of free radicals. The results are applied to the consideration of the effects of irradiating a biological entity in water. A simple biological model is proposed and its properties are discussed with particular reference to the target theory.

III. Hydrogen peroxide formation in water exposed to ionizing radiations. P. BONÉT-MAURY (422–8). The production of H_2O_2 in irradiated water is discussed in detail in terms of H atoms and OH radicals, and the possible part played by H_2O_2 in the biological effects is described.

IV. A review of the evidence for the production of free radicals in water consequent on the absorption of ionizing radiations. F. S. DAINTON (428–33). The decomposition of pure water and the kinetics of many reactions in aqueous solutions under irradiation can be explained adequately in terms of radical formation. The main evidence for the formation of H and OH radicals in the water is chemical: there is less satisfactory evidence for the presence of other species. The processes of radiation-induced oxidation and reduction, and disaggregation of large molecules, are discussed, and the limitations of present knowledge on how the primary products behave are indicated.

V. Some aspects of the biological effects of ionizing radiations. W. M. DALE (433–5). Experiments with pure enzymes are described to show that (i) radiations act indirectly through the solvent, and (ii) one solute can protect another from the radiations even when the second is by itself radiation-sensitive. There is a large variation in the effectiveness of such protection substrates which also decreases in some cases with increasing concentration. These results, and radiation-induced deamination reactions, cannot be explained in terms of a simple radical picture.

VI. Radiation chemistry of organic halogen compounds. W. MINDER (435–40). The decomposition of organic halides in aqueous and non-aqueous solvents is described, and an attempt is made to explain the results in terms of energy conduction through "reacting volumes." The relationship of such reacting volumes to the target theory is discussed.

C. B. ALLSOPP

541.15

9776. Chemical effects of the $Cl^{35}(\gamma, n)Cl^{34}$ reaction in sodium chlorate. K. J. MCCALLUM AND O. G. HOLMES. *Canad. J. Chem.*, **29**, 691–8 (*Aug.*, 1951).

The distribution of Cl^{34} among different valence states following the $Cl^{35}(\gamma, n)Cl^{34}$ reaction in solid $NaClO_3$ has been investigated, using a betatron as the source of gamma rays. The percentage of the activity in the hypochlorite and perchlorate fractions differed from zero by less than the experimental error; the small activity separated with the chlorite fraction could be accounted for by an exchange reaction between chloride and chlorite ions. The major part of the activity, 91 ± 2%, was present in the chloride fraction, the remainder of the activity being present as chlorate ion. One-quarter of the activity in the chlorate fraction could be accounted for by an exchange reaction between chloride and chlorate ions. The results were not affected by an alteration in the peak energy of the gamma rays or by a change in the amount of radiation. The results are compared with those following the $Cl^{37}(n, \gamma)Cl^{38}$ reaction in the same compound.

A.

541.15

9777. A study of effect of impingement-particle velocity in radiolysis of some aromatic hydrocarbons. T. J. SWORSKI AND M. BURTON. *J. Amer. Chem. Soc.*, **73**, 3790–2 (*Aug.*, 1951).

Total-gas 100 eV yields (i.e. *G* values) in radiolysis of toluene, ethylbenzene, *i*-propylbenzene and *t*-butylbenzene in the Oak Ridge nuclear reactor are, respectively, 0·18, 0·27, 0·27 and 0·22, all values being slightly higher (10–30%) than yields obtained in electron bombardment radiolysis. At the same time, in every case studied, the ratio $G(H_2)/G(CH_4)$ is increased in reactor exposures over the ratio in electron bombardment by a factor of approximately two, the factor increasing in the order of listing above.

A.

541.15 : 539.166.93

9778. The Szilard–Chalmers process. H. A. C. MCCAY. *Progress in Nuclear Physics*, 1. *London, Butterworth–Springer; New York, Academic Press* (1950) 168–84.

Attention is confined to "hot" atoms which are isotopic or isomeric, with their parent atoms, mainly produced by (n, γ) processes or γ-radiation. Tables of about 30 examples are given, showing the method of separation. The mechanism of the process is discussed, with special reference to the chemistry of "hot" halogen atoms and the disruption of oxy-acids and their bases. The review concludes with a brief description of some applications of the process. (Bibliography of 78 refs.)

541.15 : 539.185.9

9779. The Szilard–Chalmers effect with slow and fast neutrons. W. RIEDER. *S.B. Öst. Akad. Wiss. Abt. IIa*, **159** (*No.* 3–6) 173–87 (1950) *In German.*

K and Ca permanganates were used to study the effect of variations in neutron energy on the Szilard–Chalmers process. Indications are that fast neutrons are more effective than slow but the fact that slowing

down takes place complicates the results. The effect of concentration is also studied. J. THEWLIS

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18 : 541.135

9780. The interaction of colloidal particles. VI. Application of the Stern theory of the double layer. S. LEVINE. *J. Coll. Sci.*, **6**, 1–19 (*Feb.*, 1951).

For Pt V, see Abstr. 2137 (1951). Theoretical. The author's theory of the interaction of colloid particles [*Trans Faraday Soc.*, **42B**, 102–17 (1946)] is combined with the theory of the double layer proposed by Stern [*Z. Elektrochem.*, **30**, 508 (1924)]. The method of calculation thus developed is then applied to the case of the two parallel plates and small surface potentials. The expression obtained for the mutual free energy of the plates contains three terms, one of which is of the same form as obtained by Verwey and Overbeek [*Theory of the stability of lyophobic colloids* (1948)] and two additional terms which are far from zero magnitude. J. IBALL

541.18.041.5

9781. Liesegang ring formation arising from diffusion of ammonia and hydrogen chloride gases through air. E. L. SPOTZ AND J. O. HIRSCHFELDER. Letter in *J. Chem. Phys.*, **19**, 1215 (*Sept.*, 1951).

The Liesegang ring formation involves, it has been shown, more than a 1 000-fold supersaturation of NH_3 and HCl. It appears that forces between single molecules of NH_3 and HCl are homopolar while in a NH_4Cl crystal they are ionic; hence a crystal nucleus of a critical size would render further growth comparatively easy. F. LACHMAN

541.18.043

9782. The determination of sedimentation constants from Fresnel diffraction patterns. G. KEGELES AND F. J. GUTTER. *J. Amer. Chem. Soc.*, **73**, 3770–7 (*Aug.*, 1951).

A precision method which makes use of micro-comparator measurement of fringes to locate the centre of the sedimenting boundary. These fringes, which are symmetrical in pairs about the centre of the boundary, originate with the introduction of a bar as diagonal diaphragm into the cylinder lens refractive index gradient recording optical systems. A study has been made of the concentration dependence of the sedimentation constants of several proteins. Comparison of this observed concentration dependence with available hydrodynamic theories indicates the approximate validity of the theory of Burgers for unhydrated spheres. However, it is believed that residual discrepancies between experiment and theory would justify the extension of the Burgers theory to the actual case of hydrated, elongated, interacting particles. A.

541.182.02 : 539.26/.27

9783. Recent X-ray diffraction studies on the hydrous oxides and hydroxides. W. O. MILLIGAN. *J. Phys. Coll. Chem.*, **55**, 497–507 (*April*, 1951).

A review of electron and X-ray diffraction studies carried out, since an earlier survey [see Abstr. 1628 (1942)], on hydrated forms of the oxides of Cu, Al, Cr, In, Sc and the rare earths. The methods of preparation and reported structures are given in many cases. Mention is made of multiple oxide systems and of the phenomenon therein of "mutual protection." 38 references. A. D. LE CLAIRE

541.183

9784. The effect of heat treatment on the surface properties of gibbsite. I. Adsorption isotherms of nitrogen and of oxygen at −182·7°C. S. J. GREGG AND K. S. W. SING. *J. Phys. Coll. Chem.*, **55**, 592–7 (*April*, 1951).

The isotherm graphs (the amount in c.c. adsorbed per gram of sample against the relative pressure at equilibrium) showed for N smooth curves for gibbsite heated to temperatures between 290° and 1 010°C; hysteresis was absent up to the highest relative pressures (0·25); in each case an initial steep portion was followed by a long, almost linear, portion of lesser slope. The sample prepared at 410°C was the best adsorbent for N for all relative pressures up to 0·25. The isotherms of O were reversible only at low relative pressures; a hysteresis loop was present over the whole of the higher pressure range. The isotherms taken on two samples (heated to 460° and 975°C, respectively) crossed at relative pressure of *c.* 0·70. A closed-loop type of curve was obtained for O on commercial activated alumina. It was found that the time needed for reaching equilibrium varied within wide limits (10 min and several hours) depending upon the relative pressure and particularly upon the presence of hysteresis loops. F. LACHMAN

541.183

9785. The effect of heat treatment on the surface properties of gibbsite. II. Isotherms of carbon tetrachloride vapor at 25°C. S. J. GREGG AND K. S. W. SING. *J. Phys. Coll. Chem.*, **55**, 597–604 (*April*, 1951).

Experiments with CCl_4 on gibbsite heated to various temperatures over the range 300 to 1 000°C gave isotherms with a definite hysteresis loop with each sample. Isotherms for gibbsite heated to a temperature between 450 and 1 000°C showed an additional point of inflection and a much greater length of the steep portion of the desorption branch. Experiments with alumina gave also an isotherm with hysteresis. A very long time of equilibration was found to exist for the steep, nearly vertical desorption branch. The surface area in sq.m. per gram of solid adsorbent was calculated, using the Brunauer–Emmett–Teller procedure, from the CCl_4 and N isotherms (cf. preceding Abstr.)—the two curves showing the dependence of area upon the temperature of heating display some degree of resemblance, the maximum of adsorptive power being at 410°C. F. LACHMAN

541.183

9786. A comparison of the specific surface areas of solids as calculated by the Brunauer–Emmett–Teller and the Hüttig equations. M. L. CORRIN. Letter in *J. Phys. Coll. Chem.*, **55**, 612–13 (*April*, 1951).

The B.E.T. results are more consistent for different gases on the same solid. As the specific surface area

increases (*a*) the number of isotherms yielding a Hüttig straight line increases, (*b*) the Hüttig results become more consistent, (*c*) the agreement between the two methods improves. A. H. W. BECK

541.183

9787. Adsorption studies of two silica gels and a gel-type catalyst. R. A. VAN NORDSTRAND, W. E. KREGER AND H. E. RIES, JR. *J. Phys. Coll. Chem.*, **55**, 621–38 (*May*, 1951).

Nitrogen adsorption-desorption isotherms are used to follow the stepwise sintering of a silica xerogel, a silica aerogel and a silica/alumina xerogel-type cracking catalyst. Sintering causes a proportionate decrease in adsorption throughout the isotherm for the two xerogels but the change is more complicated in the case of the aerogel. The results indicate that xerogels have a uniform pore structure and that sintering destroys pores but does not affect the remainder. The aerogel sinters with decrease in average pore size. J. IBALL

541.183

9788. Measurement of specific surface areas of nonporous powders by a pressure-decline liquid permeability method. C. G. DODD, J. W. DAVIS AND F. D. PIDGEON. *J. Phys. Coll. Chem.*, **55**, 684–98 (*May*, 1951).

The Kozeny equation is applied to the special case of a continuously decreasing pressure difference across the bed under test and two versions of the experimental apparatus are described. One version is suitable for relatively coarse powders and experiments with glass spheres of specific surface area approximately 330 cm^{-1} have shown good agreement with microscopic measurements. The other version is for particles in the sub-sieve range and results with fine quartz powder present certain anomalies. J. M. HOUGH

541.183

9789. The free energy of the double layer of a colloidal particle. S. LEVINE. *Proc. Phys. Soc., Lond. A*, **64**, 781–90 (*Sept.*, 1951).

Some theorems concerning the free energy of the electric double layer of a colloidal particle in a dilute sol are developed by making use of the Poisson–Boltzmann equation. It is shown that this free energy can be derived by employing the fictitious process of charging the excess ions in the double layer and that the surface density of ions may be an arbitrary function of the degree of charging. By integrating with respect to the charging parameter at constant surface density of ions we obtain an alternative form for the free energy which is expressed in terms of the electrostatic energy of the double layer and the excess osmotic pressure in the diffuse layer. The latter expression for the energy can also be derived by attributing to each volume element in the diffuse layer an energy term due to the thermal motion of the ions and an (electrostatic) field energy term. A.

541.183

9790. Physical adsorption of gases on porous solids. I. Comparison of loose powders and porous plugs. P. C. CARMAN AND F. A. RAAL. *Proc. Roy. Soc. A*, **209**, 59–69 (*Oct.* 8, 1951).

For the first time, comparison has been made of adsorption on a given surface both as a free surface and as the internal surface of a porous plug. In this way it has been possible to provide direct evidence both for capillary condensation and for blockage of capillaries with adsorbed layers in porous solids. Blockage produced well-marked effects only where the surface was of the order of 1 000 m^2/g and the porosity was less than 0·6. Where it was observed, it was to be noted that (i) molecules tended to be attracted into blocked capillaries, producing swelling, (ii) monolayer capacities and hence surface areas determined by the B.E.T. method were values which corresponded only to the unblocked surface area when the monolayer is nearly complete. At the low-pressure end of adsorption isotherms, plug and powder gave identical results within the limits of experimental error, i.e. better than 1%, so that, until blockage or capillary condensation was manifested, the total particle surface was accessible to adsorption. In agreement with this, the total pore volume was also accessible, since the volume adsorbed at saturation was not less than the pore volume. A.

541.183

9791. Physical adsorption of gases on porous solids. II. Calculation of pore-size distributions. P. C. CARMAN. *Proc. Roy. Soc. A*, **209**, 69–81 (*Oct.* 8, 1951).

When capillary condensation takes place, it is accompanied by multilayer adsorption in empty capillaries. To apply the Kelvin equation to pre-size distributions, it is necessary to make allowance for multilayers, and a method of carrying this out is presented. Any such calculation requires either an estimated or experimental adsorption isotherm for the same surface when capillary condensation is absent. In this paper, it was possible to apply it to the data of Pt I. Modification of the calculation when capillaries fill by blockage instead of condensation is discussed. Owing to presence of adsorbed layers, the Kelvin radius is less than the true pore radius, but it is difficult to decide upon the proper correction, and much uncertainty results for radii < 30 Å. Pore-size distribution curves were derived and compared for plugs of varying porosity. They provided strong evidence of tightly packed aggregates of particles, and of an increasing uniformity of pore size as porosity is decreased. In Carbolac 1 plugs of low porosity, a few pores with radii only a little larger than the radius of a CF_2Cl_2 molecule were encountered, but no pores were smaller. This agrees with the observation that the total particle surface was initially accessible to CF_2Cl_2 molecules, but that a rapid decrease of accessible surface took place before even a complete monolayer had been adsorbed. A.

541.183 : 53.081.1

9792. The gibbs—a rational unit for adsorption. R. B. DEAN. Letter in *J. Phys. Coll. Chem.*, **55**, 611–12 (*April*, 1951).

Suggests the reporting of all adsorption data in terms of surface concentration for which a new unit

of 10^{-10} moles per square centimetre, to be called "the gibbs" (G), is proposed. F. LACHMAN

CHEMICAL STRUCTURE 541.4/.6

541.553

9793. Proper functions of the directed valencies in the pure form of hybridization. S. SENENT AND F. SENENT. *An. Real. Soc. Esp. Fis y Quim.*, **47A**, 181–92 (*July–Aug.*, 1951) *In Spanish.*

A critical study of the Kimball method for directed hybrid valencies. With the aid of group theory the necessity for classifying the hybridization forms as pure and mixed is shown. For the former a general method for the establishment of the linear combination between the atomic orbitals which form the eigenfunction hybrid is proposed. Results are given for all the pure forms possible in the theory, with the explicit expression of the eigenfunctions hybridized and the electronic hybridization of each form. A.

541.57

9794. The C–Br bond dissociation energy in substituted benzyl bromides. C. H. LEIGH, A. H. SEHON AND M. SZWARC. *Proc. Roy. Soc. A*, **209**, 97–110 (*Oct.* 8, 1951).

The "toluene-carrier" technique has been used for the determination of the C–Br bond dissociation energies in the substituted benzyl bromides: *p*-, *m*- and *o*-xylyl bromides; *p*-, *m*- and *o*-chlorobenzyl bromides; *p*- and *m*-bromobenzyl bromides; *p*- and *m*-nitrobenzyl bromides; and *p*- and *m*-nitrilebenzyl bromides. The rate-determining step of the decompositions of all these compounds is represented by the unimolecular dissociation processes (*s*): $Ph_s . CH_2 . Br \rightarrow Ph_s . CH_2 . + Br$ (*s*), where $Ph_s . CH_2 . Br$ refers to the substituted benzyl bromide. Assuming that the frequency factor of the decomposition of each benzyl bromide is equal to the frequency factor of reaction (*u*): $Ph . CH_2 . Br \rightarrow Ph . CH_2 . + Br$ (*u*), the differences in activation energies between E_u and E_s were calculated using the relation $E_u - E_s = RT \ln (k_s/k_u)$; k_s and k_u denote the unimolecular rate constants of reactions (*s*) and (*u*) respectively. Since E_s and E_u are equal to the C–Br bond dissociation energies in the substituted benzyl bromides and benzyl bromide itself, this equation yields the differences, ΔD's, between $D(Ph . CH_2–Br)$ and the values for $D(Ph_s . CH_2–Br)$. The effect of substitution on a bond energy is contrasted with the effect of ionic reactions. A.

541.57

9795. The C–Br bond dissociation energy in halogenated bromomethanes. A. H. SEHON AND M. SZWARC. *Proc. Roy. Soc. A*, **209**, 110–31 (*Oct.* 8, 1951).

The pyrolyses of methyl bromide and of the halogenated bromomethanes, $CH_2Cl . Br$, CH_2Br_2, $CHCl_2 . Br$, $CHBr_3$, CF_3Br, $CCl_3 . Br$ and CBr_4, have been investigated by the "toluene-carrier" technique. It has been shown that all these decompositions were initiated by the unimolecular process $RBr \rightarrow R + Br$. Since all these decompositions were carried out in the presence of an excess of toluene, the bromine atoms produced were readily removed by the fast reaction $C_6H_5 . CH_3 + Br \rightarrow C_6H_5 . CH_2 . + HBr$. Hence, the rate of the unimolecular process has been measured by the rate of formation of HBr. The C–Br bond dissociation energies were assumed to be equal to the activation energies of the relevant unimolecular dissociation processes. These were calculated by using the expression $k = 2 \times 10^{13} \exp(-D/RT)$. The reason for choosing this particular value of 2×10^{13} sec^{-1} for the frequency factor of these reactions is discussed. The possible factors responsible for the variation of the C–Br bond dissociation energy in these compounds have been pointed out. A.

541.64/.65

9796. Optical rotation and chain folding in synthetic polypeptides and gelatin. C. ROBINSON AND M. J. BOTT. *Nature, Lond.*, **168**, 325–6 (*Aug.* 25, 1951).

The specific rotations of meta-cresol solutions of synthetic polypeptides of different molecular weights were measured. In addition, an estimate of the percentage of polypeptide chains in the α-configuration was made from films prepared from each different sample. There is a striking relationship between the two sets of results suggesting that optical rotatory power might be used as an indication of change of chain configuration in protein solutions. This leads to a consideration of the change in optical rotation of gelatin solutions on cooling from temps. greater than 35°c. This change, which is connected with the gelling properties, is thus linked to a change in the chain configuration. J. IBALL

CHEMICAL ANALYSIS 543/545

545.8

9797. Electrical measurement of water vapor with a hygroscopic film. E. R. WEAVER. *Analyt. Chem.*, **23**, 1076–80 (*Aug.*, 1951).

After a short description of the development of the method from its beginning, the construction and uses of two types of hygrometers are discussed: (*a*) Films of LiCl in polyvinyl chloride on a polystyrene base; these have satisfactory stability for measuring R.H. above 5%. (*b*) Films of sulphuric and phosphoric acids, which are much more sensitive, but require calibration at the time of use.

545.8

9798. Sensitized paper for estimation of mercury vapor. F. STITT AND Y. TOMIMATSU. *Analyt. Chem.*, **23**, 1098–1101 (*Aug.*, 1951).

545.8 : 536.423.45

9799. Determination of moisture in gases by automatic dew point equipment. R. M. ILFELD. *Analyt. Chem.*, **23**, 1086–9 (*Aug.*, 1951).

The instrument comprises a mechanical refrigerator, a heater-controlled mirror assembly, and electronic controls to observe and control the amount of dew formed. The mirror reflectance is monitored by a photocell, and the resulting signal converted into an increase or decrease in the amount of heat supplied to

the mirror. The equipment is designed for normal service under industrial plant conditions. A.

545.82

9800. On the dependence of the position of spectral lines on the temperature of the spectrograph and its effect on qualitative and quantitative analysis. A. SCHÖNTAG. *Z. wiss. Photogr.*, **46** (*No.* 4–6) 99–105 (1951) *In German.*

Alteration of refractive index of the spectrograph prism with temp. causes an apparent shift of the recorded lines. The shift is towards longer wavelengths as the temp. increases, and lines of longer wavelength are affected more than those of shorter wavelength. If adjacent lines of different profile are photometered for quantitative analysis, their relative intensity may be seriously affected by lack of constancy in prism temp. S. T. HENDERSON

545.82 : 535.343.4–15

Quantitative determination of atmospheric gases by infra-red spectroscopic methods. *See Abstr.* 9386

545.822

9801. A spectrocomparator for the analysis of mixtures using cathode-ray tube presentation of absorption difference spectra. E. F. DALY. *J. Sci. Instrum.*, **28**, 308–13 (*Oct.*, 1951).

Analysis of an *n*-component liquid or gaseous mixture may be accomplished by preparing from known proportions of the pure components a mixture spectrally indistinguishable from that to be analysed. This method does not assume additivity of absorptions, but is laborious if attempted by standard spectrum recording techniques. The usefulness of this method may be extended by an apparatus described here and termed a spectrocomparator. This instrument combines repeated scanning of a given spectral region and presentation of steady spectra on a cathode-ray tube with a system by which the difference between the absorption spectra of two samples is displayed. An analysis may then be performed by using a fixed sample cell in one beam, and in the other a cell of similar path through which is circulated a reference mixture of known and variable composition or *n* variable path cells each containing one or more pure components. A.

545.822 : 535.89

Igniting an arc for spectrographic analysis in vacuum. *See Abstr.* 9412

545.823 : 535.343.4–31

9802. Some considerations on the detection of gases and the measurement of their pressure by light absorption in the far ultraviolet. J. ROMAND, V. SCHWETZOFF AND B. VODAR. Letter in *J. Phys. Radium*, **12**, 633–4 (*May*, 1951) *In French.*

The method is described and examples of its practical applications given, e.g. detection of leaks in apparatus and measurement of low pressures. W. R. ANGUS

545.827

9803. Radiochemical determination of chromium, vanadium and molybdenum by means of radioactive silver. J. GOVAERTS AND C. BARCIA-GOYANES. Letter in *Nature, Lond.*, **168**, 198 (*Aug.* 4, 1951).

A solution of $AgNO_3$ prepared from radioactive Ag^{110} is used to precipitate the above metals as chromate, vanadate and molybdate, respectively. Standard curves are given relating the activities of these precipitates with the respective metal contents. The method is rapid and accurate, and without special refinements less than 1 mg of metal can be determined. J. GRANT

CRYSTALLOGRAPHY 548

548.0

9804. The preparation of high melting point metal single crystals and bicrystals with pre-determined crystallographic orientation. K. V. GOW AND B. CHALMERS. *Brit. J. Appl. Phys.*, **2**, 300–3 (*Oct.*, 1950).

A method is described for the preparation, in metals of high melting points, of single crystals and bicrystals with predetermined crystallographic orientations. The crystals are grown horizontally in an atmosphere of A; heating is by graphite rod resistors. The method has been applied to Cu and Ni. A.

548.1

9805. The choice of triclinic lattice elements. J. WASER. *Texas J. Sci.*, **3**, 202–3 (*June* 30, 1951).

It is proposed that the edges of the unit cell should be the three shortest non-coplanar lattice vectors, such that the angles between them are all obtuse or all acute. This modifies Buerger's convention (*X-ray Crystallography*, New York, Wiley, 1942). A. R. STOKES

548.12

9806. Space-group symmetry and methods of crystal-structure calculation. I. A. NIGGLI AND P. NIGGLI. *Z. angew. Math. Phys.*, **2**, 217–32 (*July*, 1951) *In German.*

A new symbolism is given for describing the symmetry operations of a space-group in terms of the effect of these operations on the co-ordinates of a point. A. R. STOKES

548.3 : 537.226.2

9807. New varieties of monocrystals of barium titanate. I. N. BELYAEV, N. S. NOVOSILTSEV, A. L. KHODAKOV AND E. G. FESENKO. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 5) 875–7 (1951) *In Russian.*

$BaTiO_3$ crystals were prepared by heating $BaCl_2 + BaCO_3 + TiO_2$ in corundum crucibles at various temperatures from 750°–1 200° or by heating $BaTiO_3$ in a Na_2CO_3 and K_2CO_3 melt. 3 new varieties of crystals were obtained and all had density 5·8 g/cm³, refractive index 2·4 and chemical formula $BaTiO_3$. At 20° all were cubic and appeared as cubes, octa-

hedra and prisms, but differed in their dielectric properties: (*a*) had maximum ε at $-70°$ of 5 000 for 1 Mc/s and 6 000 for 50 c/s; (*b*) had maximum ε of 4 000 at $+10°$; (*c*) was not ferroelectric and ε was almost independent of temperature. A. L. MACKAY

548.5 : 538.69

9808. Influence of a magnetic field on the crystallization and composition of mixed crystals. G. MAYR. Note in *Z. Naturforsch.*, **6a**, 467 (*Aug.*, 1951) *In German.*

Reports a series of measurements on the magnetic, electrical and structural properties of the following substances which have been heat treated in a magnetic field: Bismuth and cadmium crystals, Co–Cu alloys, paramagnetic salts (nickel sulphate and nitrate, cobalt chloride, silver nitrate). E. P. WOHLFARTH

548.52

9809. The growth of quartz in alkali halide solutions. J. F. CORWIN AND A. C. SWINNERTON. *J. Amer. Chem. Soc.*, **73**, 3598–601 (*Aug.*, 1951).

The conditions necessary for the growth of α-quartz in alkali halide solutions at high temperatures and pressures using fused quartz as a source material and α-quartz as seed have been described. The process is isothermal and depends on the greater solubility of the fused silica for saturation of the solution. X-ray analysis of materials and physical measurements made at room temperature have been extrapolated to the conditions of growth and a possible mechanism for the reaction is discussed. A.

548.52

9810. Observations on carborundum of growth spirals originating from screw dislocations. A. R. VERMA. *Phil. Mag.*, **42**, 1005–13 (*Sept.*, 1951).

Numerous growth spirals with shapes ranging from circular to regular hexagonal have been observed on carborundum crystals of types I and II, by coating the crystal faces with a thin film of silver of reflectivity nearly 90% and then working in reflection, using phase contrast illumination. The shapes of these spirals, in relation to the crystal structure, are shown to be in accordance with the predictions of Frank's theory. On a type II crystal, hexagonal interlaced spirals have been observed. The annihilation of growth fronts where they meet, and other properties of growth fronts are illustrated and hence the observed patterns for two or more screw dislocations are explained. The observed density of dislocations ranges from small values up to a maximum of 10^4 per cm^2. For a typical circular spiral the calculated values of the radius of the critical nucleus is 2 μ and supersaturation is 0·2%. By the application of multiple-beam interference, using both Fizeau fringes and fringes of equal chromatic order, the step heights in spirals have been measured accurately for type II crystal and found to be 15 Å. This is equal to the height of the unit cell, proving that these are growth spirals originating from screw dislocations, in exact accordance with theoretical prediction. A.

548.52

9811. The growth of carborundum: dislocations and polytypism. F. C. FRANK. *Phil. Mag.*, **42**, 1014–21 (*Sept.*, 1951).

A discussion is given of certain features of the growth of carborundum as illustrated in Verma's paper. It is shown that polytypism may occur as a result of growth through the rotation of a spiral growth step. A.

548.52

9812. Growth spirals on carborundum crystals. A. R. VERMA. Letter in *Nature, Lond.*, **168**, 430–1 (*Sept.* 8, 1951).

See Abstr. 7374 (1951). There are two classes of growth spirals: (1) the spiral steps are 1 unit cell high; and (2) the step height is a multiple of 1 unit cell. The steps of spirals of the 2nd class may break up into their component steps under certain conditions.

J. A. FRANKS

548.52

9813. Growth mechanism of carborundum crystals. S. AMELINCKX. Letter in *Nature, Lond.*, **168**, 421–2 (*Sept.* 8, 1951).

Steps corresponding to a height of ½ unit cell have been observed on a c(0001) face of a carborundum crystal type 6H. See also preceding Abstr.

J. A. FRANKS

548.535

9814. Crystallite growth in graphitizing and non-graphitizing carbons. R. E. FRANKLIN. *Proc. Roy. Soc. A*, **209**, 196–218 (*Oct. 23*, 1951).

An investigation of the structure of carbons of different origin treated at temperatures between 1 000 and 3 000°C has shown that the graphitizing and non-graphitizing carbons form two distinct and well-defined classes. The differences in structure are apparent from the earliest stages of carbonization, and may be attributed mainly to the formation at low temperatures, in the non-graphitizing carbons, of a strong system of cross-linking uniting the crystallites. This leads to a random orientation of the crystallites in a rigid, finely porous mass. In the graphitizing carbons the cross-linking is much weaker, the structure is more compact, and neighbouring crystallites have a strong tendency to lie in nearly parallel orientation. It is shown that crystallite growth occurs by the gradual displacement of whole layer-planes or even of groups of layer-planes. The pre-orientation existing in the graphitizing carbons facilitates this process, enabling the rearrangement of the layer-planes to take place by small stages. It is the principal factor favouring crystallite growth in the graphitizing carbons. In the non-graphitizing carbons crystallite growth is impeded both by the strong cross-linking between neighbouring crystallites and by their random orientation. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

9815. A method for the approximate determination of the position of energy bands in crystals. H. MÜLLER. *Ann. Phys., Lpz.*, **9** (*No.* 2–4) 141–50 (1951) *In German.*

The Wigner–Seitz and Slater methods [*Phys. Rev.*, **45**, 794 (1934)] for determining energy bands in crystals lead to hydrogen functions, which depend

on an empirically known parameter. The effects of lattice structure and atomic structure on the bands can be separated. The energy bands of C, Si and Ge in the diamond type lattice are compared.

J. A. FRANKS

548.7

9816. Vector models of crystal structures. B. K. VAĬNSHTEĬN. *Dokl. Akad. Nauk, SSSR.*, **78** (*No.* 6) 1137–40 (1951) *In Russian.*

The treatment is one-dimensional but the conclusions also apply to a three-dimensional structure projected on to any line. A complex number Z_n represents the nth atom and has modulus ρ proportional to the weight of the atom and argument $2\pi x$, where x is the position coordinate in the unit cell. $S = (z_1, z_2 \ldots z_n)$ is the system of points representing the crystal. $SS^* = W$ which is a matrix of n^2 elements of the type $W_{ik} = z_i z_k = \rho_i \rho_k \exp 2\pi i(x_i - x_k)$. If the n^2 points are drawn out, S (or its conjugate S^*) can be picked out by the method of images as n images of each occur. If the density distribution is now continuous and $S = \rho(x)$, W then represents the Patterson integral at a particular point u. It is shown that an asymmetric structure cannot be solved directly but the possible solutions are limited. In principle centrosymmetric structures of point atoms appear soluble but the method is impracticable.

A. L. MACKAY

548.7

9817. Quantitative formulation of crystal-geometrical congruence. L. S. PALATNIK. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1141–4 (1951) *In Russian.*

Relations between indices of planes and axes of two crystal lattices which coincide in a line, plane or volume are given in vector notation. The treatment is applicable to martensite-type transformations, ageing of alloys, mechanical deformation, etc.

A. L. MACKAY

548.7

9818. Expression for the vectorial complex for each of the 230 crystal groups. J. L. AMORÓS AND M. FONT-ALTABA. *An. Real. Soc. Esp. Fis. y Quim.*, **47A,** 167–72 (*July–Aug.*, 1951) *In Spanish.*

Aims at giving appropriate expressions to calculate the development of the vectorial complex in function of the conditions of equality of the structure factors, independent of the phase constant. Some equations, valid for calculus, are given. Appropriate equations for Patterson projections are outlined also. A.

548.7 : 539.185

The scattering of neutrons by crystals. *See Abstr.* 9734

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 9741–2

548.73

9819. X-rays applied to the manufacture of low temperature coefficient quartz crystals. J. R. HALSALL. *Electronic Engng*, **23,** 298–301 (*Aug.*, 1951).

Outlines the crystallography of quartz and the variation of the properties of quartz plates with the angle of cut. Describes the methods adopted in the production of quartz crystals for setting the angle between the crystal and the saw by means of X-ray diffraction. This method makes it possible to produce crystals in large numbers with cutting errors of 5 min.

C. F. BROCKELSBY

548.732 : 537.531 : 535.34

9820. Abnormally penetrating X-rays in the Bragg case of interference. G. BORRMANN. Note in *Naturwissenschaften*, **38** (*No.* 14) 330 (1951) *In German.*

The abnormally low absorption of X-rays found for single crystals in the Laue case is now found to occur for the Bragg case. Possible explanations are discussed.

J. THEWLIS

548.732 : 537.531 : 535.34

9821. X-ray absorption in a crystal set at the Bragg angle. H. N. CAMPBELL. *J. Appl. Phys.*, **22,** 1139–42 (*Sept.*, 1951).

Whereas extinction effects would be expected to decrease the X-ray transmission through a crystal when it is set at a reflecting angle, it is shown experimentally that in many cases the transmission increases at the Bragg angle. This is believed to be due to the fact that the decrease in the effective absorption coefficient overshadows the losses due to reflection. A reconsideration of Darwin's presentation of extinction allowing for variable μ shows that the transmission may increase or decrease depending on the values of μ and p. Thus the earlier observations of Bragg and co-workers are reconciled with the observations reported here. The importance, to crystal structure workers, of determining how μ varies with direction in periodic media is obvious. [See also Abstr. 3553 (1951)]. A.

548.733

9822. A new chart for setting the Buerger precession camera. E. TAVORA. *An. Acad. Brasil. Cienc.*, **23,** 113–18 (1951).

Describes the construction and use of a compound nomogram, and claims certain advantages over that of Adams and Evans [Abstr. 2856 (1949)]. All scales are straight and no operations other than alignments are required. A. R. STOKES

548.733

9823. The utilization of a new Jong–Bouman camera. J. L. AMORÓS. *An. Real. Soc. Esp. Fis. y Quim.*, **47A,** 161–6 (*July–Aug.*, 1951) *In Spanish.*

Calculation tables are given for the constants of the apparatus for each special case, as well as the ranges to establish guide rules for the sin θ, Lorentz factor and the polarization factor. A.

548.734

9824. On a method of studying small-angle scattering of monochromatic X-rays. K. BANERJEE AND J. C. MAITRA. *Indian J. Phys.*, **25,** 141–4 (*March*, 1951).

The blurring effect of the direct beam is eliminated by reflecting the direct beam as well as the scattered one by a crystal oriented at a small deviation from the Bragg angle for the characteristic radiation. Out of the scattered beam the ray that is incident at the Bragg angle for the characteristic wavelength is reflected to an intensity comparable with that of the reflected direct beam. By rotating the crystal, varia-

tion of intensity of the scattered monochromatic radiation with angle of scattering may be studied. A.

548.734

9825. A new method of observing Compton and other incoherent X-ray scattering in crystals. H. J. GRENVILLE-WELLS. Letter in *Nature, Lond.*, **168,** 291 (*Aug.* 18, 1951).

A narrow beam of copper *K*-radiation impinging on a mosaic-type diamond gives a weak divergent-beam diffraction photograph. This must be due to Compton scattering or imperfection (including thermal) scattering, or both. A. R. STOKES

548.735.44

9826. A method for making accurately reproducible masks of the Huggins type. B. HOWELL, C. J. CHRISTENSEN AND D. MCLACHLAN, JR. *Nature, Lond.*, **168,** 282–3 (*Aug.* 18, 1951).

The masks have black-and-white patterns with sinusoidally shaped boundaries, and are reproduced photographically. A. R. STOKES

548.735.46

9827. New methods of direct structure determination using modified Patterson maps. D. ROGERS. Letter in *Research, Lond.*, **4,** 295–6 (*June*, 1951).

The methods can be used (1) when some of the atoms have been located; (2) when the major part of the structure is known and details are sought; (3) when isomorphs are available. The modified maps give the electron density plus a diffuse background.

A. R. STOKES

548.735.46

9828. Spherical Patterson sections. A. L. MACKAY. Note in *Acta Cryst.*, **4,** 477–8 (*Sept.*, 1951).

By graphical means the value of the Patterson function at points on the surface of a sphere of radius 1·56 Å about the origin has been calculated for crystals of $\beta - Ca_3(PO_4)_2$. Only peaks due to P–O vectors occur in this surface and from them the orientation of PO_4^{---} groups in the compound can be obtained. A. L. MACKAY

548.736.3

9829. The relationship between lattices of the types NiAs and Ni_2In and certain orthorhombic lattices. P. I. KRIPYAKEVICH. *Dokl. Akad. Nauk, SSSR,* **79** (*No.* 3) 439–42 (1951) *In Russian.*

Structures of the types Co_2Si, Cr_3C_2 and MnP (space group *Pbnm*) are shown to be closely related to Ni_2In and NiAs structure types (space group *C6/mmc*). The existence of a new type of A_3B_2 structure is predicted which may occur in the fully ordered γ'-phase of NiSn and Mn–Sn alloys. Cr_3Si_2 and Cr_3Ge_2 are expected to have the Cr_3C_2 structure.

A. L. MACKAY

548.736.3

9830. Crystal structure of $PtPb_4$. U. RÖSLER AND K. SCHUBERT. Note in *Naturwissenschaften,* **38** (*No.* 14) 331 (1951) *In German.*

Tetragonal, $P4/nbm$, $a = 6·653 \pm 10$, $c = 5·968 \pm 10$ kx, 2 Pt in (*a*), 8 Pb in (*m*) with $x = 0·175$, $z = 0·255$, from powder and rotation photographs.

A. J. C. WILSON

548.736.3

9831. The crystal structure of Co_2C. R. JUZA AND H. PUFF. Note in *Naturwissenschaften,* **38** (*No.* 14) 331–2 (1951) *In German.*

Orthorhombic, $D_{2h}^{14}[Pbcn]$, $a = 2·89$, $b = 4·45$, $c = 4·36$, $Z = 4$, 4Co in (*c*) with $y = 0·158$, from powder photographs. It is not isotypic with any known iron carbide, but is related to the hexagonal Fe_2C. A. J. C. WILSON

548.736.3

9832. Dimensions of the nitrite ion. M. R. TRUTER. Letter in *Nature, Lond.*, **168,** 344 (*Aug.* 25, 1951).

Redetermination of the structure of sodium nitrite gives: bond-length N–O = 1·13(9) A; angle O–N–O = 132° 48′. A. R. STOKES

548.736.3

9833. The state of ionization in lithium hydride. M. S. AHMED. *Phil. Mag.*, **42,** 997–1004 (*Sept.*, 1951).

Single crystal photographs of LiH have shown that the structure is of the NaCl-type, $a = 4·09$ Å, $Z = 4$. The intensities of reflection from planes having all even and all odd indices give atomic form factors for Li^{+X} and H^{-X} respectively which, when extrapolated to $(\sin\theta)/\lambda = 0$, lead to the value $X = 0·25 \pm 0·25$. This result is not modified by taking into consideration the thermal vibrations of the atoms. It follows therefore that in the solid state LiH has only 25% ionic character, with limiting values (much less probable) of 50% ionic character or complete covalency. A.

548.736.3 : 539.26 : 538.221

Changes in lattice constants of Cr_2O_3 near the Curie temperature. *See Abstr.* 9597

548.736.3 : 550.93

9834. Cube-edges of uraninites as a criterion of age? B. WASSERSTEIN. Letter in *Nature, Lond.*, **168,** 380 (*Sept.* 1, 1951).

The variation of lattice parameter of $UO_2 + ThO_2 + PbO_2$ with composition can be used to estimate age, without recourse to the mass-spectrograph.

A. R. STOKES

548.736.4

9835. Antiferroelectric structure of lead zirconate. E. SAWAGUCHI, H. MANIWA AND S. HOSHINO. Letter in *Phys. Rev.*, **83,** 1078 (*Sept.* 1, 1951).

$PbZrO_3$ is orthorhombic with $a = 5·87$, $b = 11·74$, $c = 8·20$ Å, $Z = 8$ and space group *Pbam* or *Pba*. Displacement of the Pb ion is thought to be 0·02 Å along the *a* axis. A. L. MACKAY

548.736.5 : 548.538

9836. Structure and epitaxy of the mixed salts $NaK_5Cl_2(S_2O_6)_2$ and $NaK_2Cl(S_2O_6)$. E. STANLEY. Letter in *Research, Lond.*, **4,** 293–5 (*June*, 1951).

The two salts are similar in form, symmetry, atomic structure and refractive index. The unit cells are different but can be made nearly equal by doubling. Crystals can be grown from the two salts together. Structural "mistakes" have been observed.

A. R. STOKES

548.737

9837. Structure of synthetic polypeptides and proteins. C. H. Bamford and W. E. Hanby. Letter in *Nature, Lond.*, **168**, 340–1 (*Aug.* 25, 1951).

The authors criticize a series of helical structures put forward by Pauling and others [*Proc. Nat. Acad. Sci., Wash.*, **37**, 205, 235, 241, 251, 258, 261, 272, 282 (1951)]. A. R. STOKES

548.74

9838. The hydrogen positions in uranium hydride by neutron diffraction. R. E. Rundle. *J. Amer. Chem. Soc.*, **73**, 4172–4 (*Sept.*, 1951).

The bridge structure previously proposed is incorrect. The hydrogens lie in distorted tetrahedra, equidistant from four uranium atoms, with U — D = 2·32 Å. There are two types of uranium atoms in the structure, each with twelve nearest D atoms at this distance. The structure is illustrated. A.

GEOPHYSICS 55

550.311

9839. The instability of a fluid sphere heated within. H. Jeffreys and M. E. M. Bland. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 148–58 (*April*, 1951).

At a certain stage in the cooling of the earth a type of circulation could arise, analogous to the cellular convection of H. Bénard. G. F. S. Hills has suggested this as an explanation of the distribution of continents. It is found that the easiest modes to excite are those in which the disturbances of temperature and radial velocity contain spherical harmonics of degree 1, and the surface currents would tend to sweep floating matter to one side. The theory shows some prospect of providing an explanation of the land and water hemispheres, though there are some outstanding difficulties. An approximate solution is also derived for a spherical mass with a rigid boundary, heated from within. It is again found that the easiest modes to excite correspond to harmonics of degree 1. A.

550.341

9840. Theoretical amplitudes of the seismic phase *PKJKP*. K. E. Bullen. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 163–7 (*April*, 1951).

Calculations have been made of the partitioning of energy of *P* waves incident from above against the boundary of the earth's inner core, and of *P* and *SV* waves incident against this boundary from below. In these calculations the inner core has been assumed to have rigidity as in an earth model based on compressibility theory. The calculations have been applied to estimating the relative amplitudes of the phases *PKJKP* and *PKIKP* at various epicentral distances for a given earthquake. It is shown that, on the assumptions made, the phase *PKJKP* is most likely to be observed over a range $130° \leqslant \Delta \leqslant 155°$ of epicentral distance, the amplitude in this range being about one-fifth of that for *PKIKP*. It is suggested that readers of seismograms who find *PKIKP* strongly recorded in this range might also look for the phase *PKJKP*; the writer of this paper would much appreciate it if observational evidence supporting the existence of the phase *PKJKP* could be communicated to him for purposes of collation. A.

550.341.2

9841. Crustal layers of the earth. A. L. Hales; P. L. Wilmore. Letters in *Nature, Lond.*, **168**, 163–4 (*July* 28, 1951).

Hales: A study of the crustal layers in the western Transvaal by Wilmore, Hales and Gane (*Bull. Seis. Soc. Amer.*, in the press) shows that at distances of 220–300 km there was a large and well-defined phase which was rather more than 1 sec early with respect to the P_1-line ($V_1 = 6{\cdot}09$ km/sec). Various suggestions to explain this are put forward; it is concluded that there is a change in the composition of the crustal layers at depth, in such a way that the velocity ratio for the *P*- and *S*-waves increases at depth. It is further pointed out that the seismic ovservations in South Africa are consistent with the view that the crustal layers increase in basicity with depth.

Wilmore: Referring to Hales's letter, the author supports the evidence produced against the postulate of uniformity for the materials above the Mohorovicic-Discontinuity. He emphasizes, however, that it seems premature to assert that horizontal stratification of the proposed appropriate materials provides the only possible explanation of the anomalous seismic results obtained in the recent Transvaal survey. A. BEER

550.381 : 538.3

9842. On the generation of magnetism by fluid motion. H. Bondi and T. Gold. *Mon. Not. Roy. Astron. Soc.*, **110** (*No.* 6) 607–11 (1950).

It is shown that in a liquid of infinite conductivity hydrodynamic motion may result in an indefinite increase of the strength of the internal magnetic field; but that the external field is severely limited in the case when the volume occupied by the liquid is simply connected. These limitations disappear when the volume is multiply connected. The case of finite conductivity is then briefly discussed. A.

550.837.3

9843. Electric currents in a continuously variable medium. A. Huber. *S.B. Öst. Akad. Wiss. Abt. IIa*, **159** (*No.* 3–6) 71–82 (1950) *In German.*

An entirely mathematical paper on the way the potential at the surface of the earth depends upon the specific resistivity as a function of depth in the normal electrical resistivity method of geophysical prospecting. The solution is obtained from the potential equation in cylindrical co-ordinates. J. M. HOUGH

550.839 : 539.16.08

9844. Aerial prospecting for radioactive minerals. D. H. Peirson and E. Franklin. *Brit. J. Appl. Phys.*, **2**, 281–91 (*Oct.*, 1951).

The γ-ray flux over a radioactive mineral deposit has been calculated and expressions derived for the

variation with operational flying conditions. An airborne equipment comprising 49 G.M. tubes was designed to investigate the overall sensitivity and the practical problems arising from the use of such a method of prospecting. Thus a surface mineral deposit of concentration factor (% U_3O_8 by weight) × area (sq. yd) of about 100 is just detectable above "background" fluctuations at an altitude of 500 ft overhead and speed of 120 m.p.h. The effect of deposit and background activity upon the comparative performance of Geiger and scintillation counters is such that a practical improvement of three times may be expected from the scintillation counter. A.

550.93 : 548.736.3

Cube-edges uraninites as a criterion of age? *See Abstr.* 9834

ATMOSPHERE . METEOROLOGY 551.5

551.51

9845. Stratification and nomenclature of the atmosphere. D. SELVAGGI. *Riv. Met. Aeronaut.*, **10** (*No.* 2) 21–6 (*April–June*, 1950).

Definitions of various layers of the atmosphere (stratosphere, ionosphere, exosphere, tropopause, etc.) as proposed by Flohn and Penndorf are reviewed and discussed at length. METEOROLOGICAL ABSTRACTS

551.510.41

9846. Variations in the chemical composition of stratosphere air. K. F. CHACKETT, F. A. PANETH, P. REASBECK AND B. S. WIBORG. *Nature, Lond.*, **168**, 358–60 (*Sept.* 1, 1951).

Samples of stratospheric air taken previous to Dec. 1950 have shown no indication of variable chemical composition from ground-level to 60 km. However, samples obtained by a new technique during a rocket flight from White Sands, New Mexico, on Dec. 19, 1950, show on analysis a marked increase of He and Ne, and a deficit of A, with altitude. This result agrees with the supposition that sampling occurred in a region (64–72 km) where gravitational separation was effective. This is the first time such an effect has been detected with certainty.

D. R. BÀRBER

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 9621–2

551.521 : 551.510.5

9847. Radiation in the troposphere and lower stratosphere. R. M. GOODY AND G. D. ROBINSON. *Quart. J. Roy. Met. Soc.*, **77**, 151–87 (*April*, 1951).

This review is restricted to seven topics capable of physical interpretation and to energy transfer in the atmosphere. (1) Solar radiation as a source and the distribution of solar energy at the atmospheric limit and over the earth's surface, together with the albedo of the earth, are considered. (2) For terrestrial radiation sections deal with radiation charts, the divergence of radiative flux and the limitation of methods of computing it. (3) The thermal effects of solar and terrestrial radiation are treated under the divergence of flux of terrestrial radiation, absorption of solar radiation in the atmosphere, and sources and sinks in the atmosphere. (4) Under infra-red spectroscopy the importance of the infra-red spectroscope, prismatic and grating solar spectra, the long absorbing path at ground level, solar spectroscopy at high altitudes, emission spectroscopy and pressure measurements are discussed. (5) The absorption and emission spectra of atmospheric gases are examined in relation to position and intensity of absorption lines, line shapes and widths and absorption by a band spectrum, pressure effects and absorption and emission by water vapour. (6) The radiation and structure of the lower atmosphere are discussed with reference to CO_2 and O_3 absorptions and the thermal equilibrium at the tropopause. (7) Measurements of scattering, the effects of molecular and liquid-drop scattering, and the information obtainable from scattering are examined. (Bibliography. 98 refs.)

R. S. READ

551.521.1

9848. Studies of solar radiation. T. E. AURÉN, *Ark. Geofys.*, **1**, *Paper* 14, 395–439 (1951).

Many observations of direct radiation in a clear sky were made at Stocksund, 1938–42 and 1947–49, and some at Abisko and Öregrund in 1948, excluding the range 480–623 mμ, and corrected for mean distance from the sun. Curves show the total and long-wave radiation for various solar altitudes. The amount of solar energy is tabulated to show the number of days, in months, for clear or partially clear and for cloudy days, in 10% ranges of the mean and with the respective means of relative insolation for Stocksund. The methods used to determine the sky radiation near the sun, the variation in spectral composition on clear days and the determination of the constants of the instruments used in global radiation are described. Earlier observations and calculations of the solar constant are examined critically and sources of error explained. The most probable value is quoted as 1·77 cal/cm²/min.

R. S. READ

551.521.63

9849. Ultraviolet spectral distribution of radiant energy from the sun. R. STAIR. *J. Res. Nat. Bur. Stand., Wash.*, **46**, 353–7 (*May*, 1951).

Data are given for wavelengths extending below 300 millimicrons for air masses approximating $M = 1 \cdot 4$. The equipment and method employed permit the rapid acquirement of a prismatic ultraviolet spectral energy curve at sea level showing greater Fraunhofer structure than previously obtained even at desert and mountain stations. Other applications of this equipment, for example, in the study of total ozone and in sky-light spectral-energy distributions, are suggested. A.

551.524.7

9850. The temperature of the upper atmosphere. D. R. BATES. *Proc. Phys. Soc., Lond. B*, **64**, 805–21 (*Sept.*, 1951).

The properties of a number of simple models of the upper atmosphere are tabulated. A study is made of

the thermal equilibrium in the region of the *F* layers. The rate at which energy is gained from ionizing photons is estimated. Various loss processes are examined. It is found that the most important is conduction, and the next most important is probably emission by the magnetic dipole connecting the two low levels of the ground term of atomic O. These are so effective indeed that the energy source first considered appears inadequate to maintain the high temperature the upper atmosphere is generally supposed to possess. Alternatives are investigated. Sufficient energy might conceivably be supplied either by band absorption by NO, or by incoming interstellar matter: but neither source is attractive. Attention is drawn to the possibility that the original estimate of the contribution from ionizing photons may be much too small. This estimate is based on radio measurements. It is shown that these only give a lower limit to the electron production rate: for certain ions may be removed so rapidly by recombination that they would escape detection even if their formation rate were greater than that of the dominant ions in the layers. The suggestion is tentatively made that heat is supplied to the upper atmosphere mainly by non-observed ionization. It is pointed out that owing to the possible existence of such ionization, the measurements of the radio scientists cannot be assumed to give the intensity of the solar emission beyond the Lyman limit. The temporal varitaion of the temperature is briefly discussed. A.

551.543.1

9851. The semidiurnal tidal oscillation of the earth's atmosphere. H. L. Stolov. *Amer. J. Phys.*, **19**, 403–11 (*Oct.*, 1951).

The semidiurnal barometric oscillation, with maxima at about 10 a.m. and 10 p.m. local solar time, is interpreted according to current theory as an air-tide. Although the lunar tidal force is 2·2 times more powerful than the solar, and hence lunar tides in the oceans are 2·2 times stronger than the solar, this is not found to be the case in the atmosphere. The observations show a solar semidiurnal atmospheric oscillation about 100 times greater than might be expected, and a very feeble lunar oscillation. The difficulty is resolved with a suggestion by Kelvin. This is the famous "resonance theory," and illustrates how the effect of a comparatively small tide-generating force might be magnified, if the atmosphere had a period of free oscillation close to 12 solar hours. The linearized equations of atmospheric oscillations are stated, tidal wind fields indicated and conclusions summarized. A.

551.593.9

9852. Influence of water vapours and carbon oxides and nitrogen on the luminescence of the night sky. V. I. Krasovskiĭ. *Dokl. Akad. Nauk*, **78** (*No.* 4) 669–72 (1951) *In Russian.*

The important reactions considered are $H_2O + O \rightleftarrows OH + OH$; $H + CO + M \rightarrow HCO + M$ (where M is any molecule or atom occurring in the atmosphere); $HCO + HCO \rightarrow H_2CO + CO$, by which Wild proved the occurrence of formaldehyde in the atmosphere of Venus, and to which a parallel was found in 1946 when the solar radiation was directly observed at altitudes > 50 km and an absorption band $\sim 2\,850$ Å was discovered near which the maximum absorption of aldehydes and ketones is located, organic compounds of which formaldehyde is the simplest. Furthermore, $NO + O \rightarrow NO_2 + h\nu$; $NO_2 + O \rightarrow NO + O_2$. Atomic oxygen in the ^1D and ^1S states has an excitation energy exceeding the activation energy of reaction (1). Thus H_2O must be regarded as the most active quencher of excited metastable states of atomic oxygen and the hydroxyl can therefore only be formed in the ground state of oscillation. The possible maximum excitation of OH corresponds to the second oscillation level in the case $O(^1D)$ and to the 9th level of $O(^1S)$. Water vapour dissociates into OH and H only under radiation $\lambda < 1\,400$ Å. Such a process is only possible in the ionosphere. Reaction (1) proves that H_2O vapour may dissociate into OH wherever there are excited metastable O-atoms. In a sustained reaction between OH and O or N atomic H may appear independently of the presence of radiation $< 1\,400$ Å. The quenching effect of H_2O vapour on excited atomic O which reduces the intensity of the known emission of the night sky near 6 300 and 5 577 Å may be used as a criterion of the moisture content of high layers of the atmosphere. The 5 577 Å radiation emitted at the lowest level may be totally quenched in the zone of active formation of the silver clouds. This opens a way for using luminescence of the night sky as a new means of meteorological investigation and prediction.

B. F. KRAUS.

551.593.9

9853. Details of the night-sky spectrum between 9 500 and 12 000 Å. V. T. Lukashenya and V. I. Krasovskiĭ. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 2) 241–4 (1951) *In Russian.*

Analyses the results of further experimental research [Abstr. 3597, 7648, 9158 (1950) 6644 (1951)] carried out by means of two diffraction-grating spectrographs (dispersion 850 and 150 Å/mm, resolving power 30 and 5 Å, respectively, width of the slit image on emulsion 0·03 mm, maximum density of blackening = 2), and tries to identify the lines obtained.

F. LACHMAN

551.594 : 629.135 : 621.319.7

9854. The electrical charges on an aeroplane under icing conditions in thunderclouds. H. Meinhold. *Geofis. Pura Appl.*, **19**, 176–8 (*April–June*, 1951) *In German.*

The results are described of a test flight in a specially equipped aeroplane. Ice formation on the aeroplane in a thundercloud produced heavy negative charges on the plane whereas, after de-icing, a weak positive charge remained. The field strength in the cloud is found to amount to 55 V/cm. The observations are stated to be in agreement with earlier laboratory measurements [Abstr. 5802 (1950)]. R. H. GOLDE (R)

551.594.21

9855. The distribution of electricity in thunderclouds. B. F. J. Schonland and D. J. Malan. *Arch. Met., Geophys. Bioklimatol., Ser. A*, **3** (*No.* 1–2) 64–9 (1950) *In German.*

A large thundercloud consists of a number of

separate bipolar generators associated with separate cells forming the cloud. Evidence obtained by Simpson with the alti-electrograph showing that the lower negative poles of these generators are usually at or above the freezing level is supported by three different arguments based upon the study of lightning discharges to earth. It is shown that positive point discharge from the ground may produce isolated pockets of positive charge in the actual base. An outline is given of recent experimental results which throw light upon the manner in which the lower negative poles of these separate generators link up with the channel of the first stroke.

METEOROLOGICAL ABSTRACTS

551.594.21

9856. The distribution of electricity in thunderclouds. D. J. Malan and B. F. J. Schonland. *Proc. Roy. Soc. A*, **209**, 158–77 (*Oct.* 23, 1951).

The heights of the charges involved in the separate strokes of lightning flashes to ground have been estimated by five different methods. The results agree in showing that successive strokes tap progressively higher regions of the cloud. The average height for first strokes is 3·7 km above the ground (5·5 km above mean sea level) rising to a maximum of about 9·0 km (10·8 km above m.s.l.) for strokes of high order. The average increase in height is 0·7 km per stroke, the steps tending to be smaller the greater the number of strokes in a flash. It is concluded that the negative charge taking part in a flash to ground is contained in a nearly vertical column which is on occasion 6 km long and whose base is about 1 km above the actual cloud-base. The temperature at the bottom of the column is in the neighbourhood of 0°c, and its top frequently reaches to the −40°c level. It is suggested from this evidence that the charge is generated by freezing or sublimation processes at the top of the column, and that the lower negative pole is subsequently carried downwards on large hydrometeors falling under gravity. From a discussion of type β leaders it is shown that positive pockets of space-charge are often situated in the base of the cloud, and that these may derive their charge from point-discharge ions rising from the ground. The discharge of the negative column to ground is in many cases triggered off by the strong field between such a pocket and the bottom of the column. A.

551.594.22 : 551.501.7

9857. Measurements by airplane of electric charge passing vertically through thunderstorms to ground. G. R. Wait. *Arch. Met., Geophys. Bioklimatol., Ser. A*, **3** (*No.* 1–2) 70–6 (1950) *In German.*

A revised electrical balance sheet suggests that insufficient negative charge is returned to ground by thunderstorms to maintain loss in fair weather. To obtain further data, measurements of vertical current density were made by aeroplane above thunder clouds at 40–50 000 ft. Vertical gradients in V/cm are shown graphically for various traverses. The direction of the resultant current was always such as to maintain a negative charge over fair weather parts of the earth and of the right order of magnitude (0·6–6 amp, average 1 amp). The bipolar nature of thunderstorms is supported. Electrical conductivity increased roughly as the square of the altitude. No charge in the conductivity due to a thunderstorm was detected.

METEOROLOGICAL ABSTRACTS

551.594.221

9858. Investigations on the spectra of lightning flashes. I. A study of the spectra, from 3 830 to 6 570 Å by means of slit spectrographs. J. Dufay and M.-L. Tcheng. *Ann. Geophys.*, **5** (*No.* 21) 137–49 (1949) *In French.*

A detailed examination of 10 plates obtained with a slit spectrograph of low dispersion provides data on the wavelengths of about 80 lines, emitted by lightning spectra, between 3 830 and 6 570 Å. They are identified mainly as rays of N I, O I, N II, O II and H. The negative bands of the molecule N_2^+ are always present and generally strong. The bands of the 2nd positive system of N_2 which are strong in the ultraviolet are feeble and less numerous above about 3 830 Å. The variable relative intensity of the different lines is discussed.

R. H. GOLDE

551.594.221

9859. Investigations on the spectra of lightning flashes. II. Study of the spectrum in the violet and ultraviolet regions. J. Dufay. *Ann. Geophys.*, **5** (*No.* 26) 255–63 (1949) *In French.*

The spectrum of a lightning flash obtained with a quartz spectrograph enables a certain number of atomic rays to be detected, in particular, of molecular bands up to 2 950 Å. The most intense bands are those of N_2^+ and of $N_2(2P)$. The band 3 064 Å of OH is also present. The ozone produced by the discharge limits the spectrum towards the ultraviolet.

R. H. GOLDE

551.594.25

9860. Electric charges of the particles of precipitations. E. K. Fedorov. *Dokl. Akad. Nauk, SSSR*, **78** (*No.* 6) 1131–4 (1951) *In Russian.*

Comprehensive measurements with a set-up considerably superior to that used by Chalmers–Pascull [*Proc. Phys. Soc.*, **50** (*No.* 277) 1 (1938)] and Gunn [Abstr. 3800 (1949)] yielded average charges 1/10 of Chalmers–Pascull's values and maximum and minimum values 30× smaller than those of the authors mentioned. A particular advantage of the author's instrument was that it was protected by a guard-ring, which made erroneous measurement impossible. Also, it had an improved rapid recording mechanism. The distribution curves taken show steep precipices, especially for extreme charges, but also in the overall distribution curve. The pulsations in the electric characteristics of precipitations noticed by previous workers were confirmed, with the further observation that positive and negative charges increase and decrease simultaneously, often independently of the intensity variations of the rain. The electrification mechanism in different parts of the same cloud and at the same level, but at a distance of several 100 m, is thus different, but provides positive and negative charges.

B. F. KRAUS

551.594.25

9861. Charges from rime layers and their contribution to the electrification of thunderclouds. A. Kumm and F. Wolf. Note in *Naturwissenschaften*, **38** (*No.* 13) 301 (1951) *In German.*

The charges are examined which are generated

when small ice particles are broken out of rime deposits on a strongly under-cooled metal body. The average charge per ice particle is determined as 7×10^{-16} coulomb, but the polarity is not such as to explain the polarity distribution of an average thundercloud. R. H. GOLDE

551.594.25

9862. The origin of the electric charge on rain. J. A. CHALMERS. *Quart. J. Roy. Met. Soc.*, **77**, 249–59 (*April*, 1951).

The charges on rain, as measured by Simpson and by Hutchinson and Chalmers, during periods when point discharge occurs, can be accounted for quantitatively on reasonable assumptions in terms of the process of ion capture. The results show that the separation of charge must operate at levels down to about 800 m, and the consequences of this are discussed in relation to theories of the process of separation of charge. A.

551.594.6 : 621.396.11

9863. Short wave radio propagation correlation with planetary positions. J. H. NELSON. *RCA Rev.*, **12**, 26–34 (*March*, 1951).

A study of North Atlantic s.w. radio wave propagation conditions over a period of five years indicates correlation between ionospheric disturbance and the positions of the planets in the solar system.

W. J. G. BEYNON (R)

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.2 : 545.827

9864. An application of mass spectrometer analysis to the study of respiratory metabolism. A. W. PRATT, B. E. BURR, M. EDEN AND E. LORENZ. *Rev. Sci. Instrum.*, **22**, 694–6 (*Sept.*, 1951).

An unmodified mass spectrometer is used for high precision measurements of both the normal and abnormal components in the collected samples. From these data the oxygen consumption rate, the carbon dioxide formation rate and the respiratory quotient are calculated for physiological interpretation. A.

612.483 : 539.16.08

Measurements of radiation from the human body. *See Abstr.* 9654

612.813

9865. A particular problem of signal transmission. A. GOUDOT. *C.R. Acad. Sci., Paris*, **233**, 290–2 (*July*, 1951) *In French.*

Properties of the propagation of stimuli along nerve fibres are pointed out, which indicate an analogy with propagation in waveguide. L. PINCHERLE

612.843.21 : 537.531

9866. On the nature of retinal excitement by X-rays. V. RONCHI. *Atti Fond. "Giorgio Ronchi,"* **6**, 221–4 (*Aug.*, 1951) *In Italian.*

An account is given of the results obtained by Bellucci on the retinal excitation induced by X-rays, and, in particular, of the patterns that are seen when an eye is exposed to a very narrow or very flat beam of X-rays. The nature of the said excitation is also discussed, and some arguments are put forward, on the strength of which the hypothesis of a fluorescence of the retinal substance appears more reasonable than that of a direct excitation: this in spite of the experiments which have led Bellucci to the opposite conclusion. A.

612.843.31

9867. The binocular fusion of yellow in relation to color theories. L. M. HURVICH AND D. JAMESON. *Science*, **114**, 199–202 (*Aug.* 24, 1951).

After 10 minutes dark-adaptation, monochromatic red (671 mμ) and violet (440 mμ) were mixed binocularly with "pure" green (498·1 mμ). To the authors' surprise there resulted a hueless sensation. Since yellow was expected, they conclude that there must be a specific "yellow" excitatory process. A review of the recent literature on binocular fusion of red and green, a bibliography, and 2 diagrams are included.

R. A. WEALE

612.843.31

9868. Influence of visual adaptation on loci of constant hue and saturation. D. L. MACADAM. *J. Opt. Soc. Amer.*, **41**, 615–19 (*Sept.*, 1951).

Loci of constant hue and saturation have been determined with an artificial-daylight surround and with a surround closely matching the chromaticity of a black body at 3 200K. The results are compared with results published by Bouma and Kruithof and by Richter. Attention is drawn to doubtful assumptions on which their results are based. A.

612.843.44

9869. On the halos due to diffraction in the eye. L. RONCHI AND G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **6**, 201–14 (*Aug.*, 1951) *In Italian.*

The authors have investigated experimentally the bright and dark rings surrounding the image of a strong point source, when observed on a black background. These rings are due to the light diffracted by the cells of the transparent tissues of the eye. There is a close analogy between this phenomenon and the X-ray patterns given by amorphous solids, liquids and compressed gases. The experimental data have enabled the authors to calculate the percentage of light scattered by this cause outside a cone of any aperture. A.

612.843.61

9870. The variations of the photometric properties of the eye at photopic luminance levels. M. TESSIER AND F. BLOTTIAU. *Rev. Opt. (Théor. Instrum.)* **30**, 309–22 (*July*, 1951) *In French.*

In the 1st experiment a mixture of different ratios *A* of red and green or blue (Wratten filters) is matched in brightness to white *B*. For medium luminance

levels (216 trolands) the luminosity of the mixtures is less than that of the component lights alone at field sizes of both 2 and 15°. A 2nd experiment involving a simplified procedure confirmed these results obtained by 5 observers. In a 3rd experiment a small monochromatic central field C (1°) and a large field A, consisting again of mixtures of 2 lights, are matched in turn to a white field B (1 000 trolands). Since the spectral composition of A affects the brightness match of C, except when C is yellow and B consists of a mixture of blue and yellow, the photopic luminosity function is not thought to be invariable as implied by the C.I.E. No mention is made of fixation, and no attempt is made in (3) to differentiate between foveal and parafoveal vision or to control adaptational effects. 14 figs. are given. R. A. WEALE

612.843.63

9871. Visual power and visibility. G. J. FORTUIN. *Philips Res. Rep.*, **6**, 251–87 (*Aug.*, 1951).

The capacity of obtaining information about the electromagnetic behaviour of one's surroundings is a property exclusive to the observer and, therefore, independent of external conditions. A quantitative definition is given of this capacity, called the visual power. This definition is based on 9 120 determinations, so that generally the visual power is indeed independent of the experimental conditions. The visual power decreases with increasing age and this decline is already present at ages under twenty years. A further consideration of the results revealed the occurrence of some different visual types, one of them being due to the presence of opacities in the optical media of the eye. The distribution of the visual power and of the visual types in age groups, and definitions of visibility will be considered in subsequent papers. A.

612.843.631

9872. The resolution of double stars from the point of view of energy. A. FIORENTINI. *Atti Fond. "Giorgio Ronchi,"* **6**, 215–20 (*Aug.*, 1951) *In Italian.*

The visual resolving power has been measured by means of two luminous sources whose distance was variable. The observer's distance was also changed approaching the sources. Furthermore, the relationship has been studied between the angular resolving power, as given from these experiments, and the radiant energy falling on the observer's pupil when the eye is just able to resolve. From the various measurements results that to equal values of the resolving power correspond equal values of the energy. This is true for distances between sources and observer not less than two meters. A.

612.843.721

9873. Ocular scanning and depth perception. J. ADAMSON. Letter in *Nature, Lond.*, **168**, 345–6 (*Aug.* 25, 1951).

Experiments performed with a modified form of the Wheatstone stereoscope lead to the suggestion that two separate processes are involved in depth perception accordingly as the size of the image is smaller or larger than the fovea. In the former case stereoscopic vision depends largely on the disparity of the retinal images, in the latter it is mediated by ocular scanning. R. A. WEALE

612.85

9874. DC potentials and energy balance of the cochlear partition. G. v. BÉKÉSY. *J. Acoust. Soc. Amer.*, **23**, 576–82 (*Sept.*, 1951).

Most living tissues are in a state of continuous decomposition and simultaneous regeneration. These processes are usually accompanied by the production of d.c. potential differences between the various parts of the tissue. Such potentials were measured at different points in the cochlea of a lightly anesthetized guinea pig. The existence of these potentials makes it probable that continuous chemical processes are going on in the inner ear. This raises the question whether the electrical energy of the microphonics is obtained from the mechanical energy of the stimulus or from the chemical-energy pool. For a certain static displacement of the cochlear partition it is shown that, during a certain time interval, the amount of electrical energy consumed in the vestibular channel is greater than the amount of mechanical work done in accomplishing the displacement. A.

612.85

9875. Electrical responses to acoustic clicks: influence of electrode location in cats. W. A. ROSENBLITH AND M. R. ROSENZWEIG. *J. Acoust. Soc. Amer.*, **23**, 583–8 (*Sept.*, 1951).

When wire electrodes are placed at certain locations outside the cat's bulla, the electrical responses to intense acoustic clicks differ radically from the standard round window response. The microphonic components of the response are now greatly attenuated, and it is even possible to find a neutral area in which no microphonics are detectable; the neural components are less attenuated and can now be studied without microphonic interference. Making use of the demonstrated electrical spread of neural potentials, it is possible to find electrode locations—all outside the animal's bony wall—that will accentuate various potentials originating in the brainstem and in subcortical centres. By means of differential recording, a particular neural component can be emphasized and selected for study. At the cat's auditory cortex one can observe small potentials attributable to subcortical structures. These potentials are, in latency and behaviour, identical with "neurals" that are observed at more peripheral locations. Cortical potentials, similar to those recorded from the surface of the brain (dura mater), can also be picked up by electrodes situated on the animal's intact skull. The use of the technique of recording from intact animals should facilitate the study of many problems of auditory physiology. A.

614.898

9876. Radioactive dust separation equipment. III. A. L. BRALOVE. *Nucleonics*, **8**, 15–23, 33 (*June*, 1951).

For Pt II, see Abstr. 8401 (1951). Possible future designs of separation equipment are discussed. The methods described are based on particle growth and liquid collection, using steam injection, sudden cooling or sonic vibrations. A new method is proposed, involving the use of sound waves to impart a high-frequency vibration to the air-borne particles, thereby increasing their impingement area and making possible their removal with coarse filters. L. R. SHEPHERD

614.898, 615.849

9877. Recommendations of the International Commission on radiological protection and of the International Commission on radiological units, 1950. *Handb. U.S. Bur. Stand., No.* 47, 29 *pp.* (1950).

A convenient publication, clearly printed and arranged in booklet form, containing the resolutions of the 1950 Congress of Radiology on these subjects. See Abstr. 3554, 4013, 5959, 8399 (1951).

D. V. MABBS

615.84 : 537.226.2 : 538.569.2.047

9878. The dielectric behaviour of some types of human tissues at microwave frequencies. H. F. COOK. *Brit. J. Appl. Phys.*, **2**, 295–300 (*Oct.*, 1951).

The dielectric properties of four types of human tissues have been investigated by a coaxial line method at frequencies corresponding to free space wavelengths in the range 6 to 17 cm. The results have been examined in relation to the Debye dispersion equations and it has been found that the dielectric behaviour of some types of tissues can be described approximately by them if an additional term for ionic conductivity is included. The results have been further discussed with reference to ion and protein hydration and to the ionic conductivities of the intracellular and extracellular fluids. A.

615.84 : 537.226.2 : 538.569.2.047

9879. Dielectric behaviour of human blood at microwave frequencies. H. F. COOK. Letter in *Nature, Lond.*, **168**, 247–8 (*Aug.* 11, 1951).

Measurements have been made of the dielectric constant, $\varepsilon' - j\varepsilon''$, of whole human blood at a number of frequencies in the range $1{\cdot}78\times10^9$ c/s to $2{\cdot}36\times10^{10}$ c/s, employing co-axial line and waveguide methods. Dispersion was found to occur and the experimental results to agree within experimental error with values calculated from the Debye equations with a single relaxation time, if the dielectric losses due to an ionic conductivity was allowed for. The dispersion observed can be attributed entirely to dipolar orientation of part of the water present in blood. The ionic conductivity of the intracellular fluid is 83% of that of the plasma. T. A. CHALMERS

615.849

9880. Radiotherapeutic physics. I. The physical aspects of treatment of cancer by 22 MeV X-rays. H. E. JOHNS, E. K. DARBY AND R. O. KORNELSEN. *Brit. J. Radiol.*, **24**, 355–64 (*July*, 1951).

Measurements of "build-up" beneath the skin show a surface dose of 15% of the maximum, and this peak to occur at 5 cm depth. Compensation for target polar diagram is achieved with a copper filter absorbing approx. 50% of radiation at the centre; this causes little variation in quality. Integral dose calculations show about ⅔ the value obtained at 4 MeV. Some results are also given for sloping fields as well as for bone absorption. F. T. FARMER

615.849

9881. Radiotherapeutic physics. II. Dosage in irradiated soft tissue and bone. F. W. SPIERS; Appendix W. J. MEREDITH. *Brit. J. Radiol.*, **24**, 365–70 (*July*, 1951).

Depth-dose curves for typical 200 kV fields passing through skin, bone, fat and lung are given; these show 18% loss in the vertebral column, but compensation in lung tissue. A detailed study of dosage in a zone close to bone surface, in terms of ionizations per cm^3, is made and the bearing of this on irradiation of haversian canals is discussed. F. T. FARMER

615.849

9882. Radiotherapeutic physics. III. A survey of hospital physics activities at the Institute of Radiophysics, Stockholm. S. BENNER. *Brit. J. Radiol.*, **24**, 370–4 (*July*, 1951).

Some details of a "flash röntgen tube" discharging 0·27 mfd. at 1 MeV, and using a conical anode surrounded by a circular cathode, are given. The measurement of beta-rays in solution and of neutrons by means of a cellulose sponge are also discussed, as well as the design of a combined dose and dose-rate measuring instrument for therapy. F. T. FARMER

615.849

9883. Radiotherapeutic physics. IV. Some developments of the physical aspects of teleradium therapy. C. W. WILSON. *Brit. J. Radiol.*, **24**, 374–80 (*July*, 1951).

Problems in the design of 10 g radium units, including the use of U instead of W for shielding, the provision of circular and rectangular fields at two focal distances, and technical aids to beam direction are discussed briefly. F. T. FARMER

615.849

9884. Radiotherapeutic physics. V. Dosage control in interstitial gamma ray therapy. W. J. MEREDITH. *Brit. J. Radiol.*, **24**, 380–4 (*July*, 1951.)

A brief review of the problem, including direct ionization measurements, reconstruction of an implant from stereographic views, and calculation of dosage from radiographs in two perp. directions.

F. T. FARMER

615.849

9885. Radiotherapeutic physics. VI. Some aspects of the problem of dosage estimation in X-ray treatment. L. F. LAMERTON. *Brit. J. Radiol.*, **24**, 385–8 (*July*, 1951).

Difficulties in dosage prediction are reviewed and the use of "iso-contribution curves" for determining total dose at any point in an irradiated medium is outlined. F. T. FARMER

615.849

9886. Radiotherapeutic physics. VII. An instrument for dosage estimation with fields of any size and shape. B. M. WHEATLEY. *Brit. J. Radiol.*, **24**, 388–91 (*July*, 1951).

Integration of the scatter function at any depth is achieved by rotating a sector representing this function in a light beam whose area equals the size of the X-ray field, and measuring total current in a photocell. Rapid determinations of iso-dose curves are possible.

F. T. FARMER

616–073.75 : 537.542

A scintillation counter for chemical use. *See Abstr.* 9551

TECHNICAL MATERIALS 66/67

666.22 : 778.33

9887. Glasses transparent to X-rays. N. J. KREIDL. *Glass Ind.*, **31**, 138–41, 154 (1950).

The investigation reported here of glasses transparent to X-rays covers glass formation in the system, Na_2O . BeO . B_2O_3. A suitable procedure was worked out for the chemical analysis of glasses in this system. PHOTOGRAPHIC ABSTRACTS

669

9888. On a method of production at room temperature of precious metal alloys in powder form. F. HUND AND J. MÜLLER. Note in *Naturwissenschaften*, **38** (*No.* 13) 303 (1951) *In German.*

Ag–Hg alloys, with up to 50% by weight Hg, were prepared by formaldehyde reduction of alkaline solutions containing Ag and Hg nitrates. X-ray measurements confirmed that the products were true alloys. A. D. LE CLAIRE

PHOTOGRAPHY 77

771.35

9889. Resolving power in photography. A. BOUWERS. Letter in *Appl. Sci. Res.*, **B2** (*No.* 3) 241–4 (1951).

The optimum resolving power of a lens-film combination is said to occur with a film of speed and resolution intermediate between Panatomic X and Super XX with lens apertures larger than *f*/6·3. The use of large aperture systems with fine grain films is recommended. R. W. FISH

771.36 : 621.383

9890. Use of image phototube as a high-speed camera shutter. A. W. HOGAN. *J. Soc. Mot. Pict. Televis. Engrs*, **56**, 635–41 (*June*, 1951).

Image convertors are used in photography for single- or multiple-frame high-speed camera shutters and exposures of the order of 10^{-8} sec have been obtained. Other applications are high-speed stroboscopes, colour television, etc. A high-impedance power supply circuit is given for efficiently working the pulse circuit of an image convertor. W. SUMMER

771.5

9891. Developers for hot-drum processing machines. A. V. HOLDEN, G. I. P. LEVENSON AND N. WELLS. *J. Sci. Instrum.*, **28**, 318–19 (*Oct.*, 1951).

Photographic developers recommended for use with the machine for the rapid processing of trace recordings [Abstr. 6924 (1950)] are described. A.

771.53

9892. On the shrinkage factor of photographic plates. L. JENNY AND T. HÜRLIMANN. *Helv. Phys. Acta*, **24** (*No.* 3) 235–44 (1951) *In German.*

Three methods for measuring this are compared. They consist in (*a*) measuring the thickness of the emulsion layer before and after fixation, (*b*) evaluating tracks with different inclination of known length and (*c*) determining the composition of the emulsion by differential weighing. All values determined by these methods show good agreement. Fresh hardening fixers increase the factor of shrinkage up to 15% above the value found with normal fixing baths. Old or used hardening fixers on the other hand give no or only a small increase in the factor of shrinkage. The influences of certain treatments preceding exposure of these special plates are investigated. In most cases they cause a reduction of the factor of shrinkage by 10–20% compared with the untreated emulsion. A.

771.53

9893. Spectral sensitivity and chemical sensitization of photographic emulsions. M. BILTZ. *Z. Naturforsch.*, **6a**, 366–9 (*July*, 1951).

771.53 : 621.317.79

9894. A direct-reading capacitance meter for recording the film thickness of photographic emulsions. H. BOUCKE. *Elektron*, **5**, 194–7 (*July*, 1951) *In German.*

Because of the varying conductance of the film being measured, a resonance method cannot be used. Instead, a balanced-voltmeter technique is employed. The balanced output from a 100–200 kc/s oscillator is connected through coupling capacitors to the grids of a double-triode acting as two anode rectifiers and across the anodes is connected a microammeter calibrated in percentage thickness variation. Across both triode grid-earth circuits are connected groups of fixed and variable capacitors which can be switched in and out of circuit, and amongst them is one formed by the freshly coated film running between two plates. Its capacitance appears to be $\gtrsim$ 30 pF since, after switching it into circuit, balance is restored by adjustment of a 30 pF variable capacitor. Calibration stability is ensured by the inclusion of a stabilized power pack and by providing grid bias for the triodes $-\sim$ 75 V—from the grid of the oscillator. Generally, within 3 min of switching on, the calibration stays constant indefinitely within 0·3%. The instrument can be used for measuring larger or smaller capacitances. H. G. M. SPRATT

772

9895. The fundamental process in photography. H. PICK. *Naturwissenschaften*, **38** (*No.* 14) 323–30 (1951) *In German.*

A comprehensive review of the German, British and American literature on the subject over the period 1920–51, dealing with the following aspects of the problem: important basic facts of the photographic process, ionic conductivity and disorder, the optical proofs of photochemical processes in AgBr, photoelectric conductivity and low-temperature photo-

chemistry, and alkali halides as pattern substance. The last two sections—the fundamental process in photography, and the development of the latent picture—contain an attempt to present a coherent explanation of these problems, based on literature quoted. F. LACHMAN

778.3 : 537.534.75

Range of protons in nuclear research emulsions. *See Abstr.* 9538

778.3 : 539.16.08 : 537.591.08 : 539.17

9896. Photographic emulsion technique. J. ROTBLAT. *Progress in Nuclear Physics*, 1. *London, Butterworth-Springer*; *New York, Academic Press* (1950) 37–72.

A detailed and comprehensive review giving considerable practical information and a bibliography of 185 references. Emulsions for nuclear research: The general characteristics of available emulsions are described, and the techniques of loading and sandwiching; fading of the image, and eradication of background are discussed, and processing described in some detail. Optical equipment: Microscopes, projection and reflection microscopes, photomicrography and densitometry are described. Methods of track analysis: This section provides formulae and graphs giving information on the following subjects: measurement of length and orientation of track; range-energy relation; straggling; measurement of grain density; small-angle scattering; magnetic field deflection; determination of charge; angular distribution and energy spectra. Applications: a brief review selected from nuclear physics, cosmic rays, geology and mineralogy, health monitoring, biology and medicine. 10 plates.

778.33

9897. A new approach to high resolution radioautography. R. M. FINK. *Science*, **114**, 143–9 (*Aug.* 10, 1951).

If ordinary autoradiographs are magnified beyond 10 diameters in an attempt to measure the radioisotope distribution microscopically, resolution becomes poor, since each point of photographic blackening has a surrounding "circle of confusion." Mechanical enlargement of a tissue section before autoradiography, will cause the separation between each point of radioactivity, and thus also, the resolution, to be correspondingly increased. A thin radioactive thyroid section was mounted between lead discs and subjected to large pressures in a rolling mili until it was enlarged 20 times. An autoradiograph then made, allowed detailed comparison with a photomicrograph made before enlargement. Comparative plates are shown, and possible variations of this technique to the furtherance of accurate localization of the sites at which biochemical processes in the tissue take place, are discussed. D. V. MABBS

778.33 : 539.167.3

9898. Gamma radiography in the United Kingdom. W. S. EASTWOOD. *Nucleonics*, **9**, 50–9 (*July*, 1951).

The suitability, for industrial radiography, of a number of gamma-ray emitters, which can be made by pile neutron irradiation, is discussed. Production at Harwell has been concentrated on three of these, Co^{60}, Ta^{182} and Ir^{192}. The construction activation and calibration of these sources are described and the technique of using them for the radiography of metal castings, pipes, welds, etc., is outlined.

L. R. SHEPHERD

778.33 : 778.4

9899. Essentials of stereoscopic roentgenography. L. E. ETTER. *Amer. J. Roentgenol. Radium Ther.*, **66**, 248–50 (*Aug.*, 1951).

Rules for true reproduction with a Wheatstone stereoscope are discussed. F. T. FARMER

778.33/.34 : 537.531

9900. Quantum yield of the photographic effect of X-rays as a function of wavelength and sensitization. H. HOERLIN. *Z. Naturforsch.*, **6a**, 344–9 (*July*, 1951) *In German.*

Two American X-ray film materials are described, Ansco Non-Screen, 56 μ layer thickness, Ag halide concentration 54%, and High Speed, thickness 30 μ, conc. 49%. In the former, electrons produced by hard X-rays (0·06 Å) make about 10 times as many grains developable as those from softer X-rays (1·3 Å). For High Speed film the ratio is only about 1·5. Each quantum absorbed at 1·3 Å produces one, and each quantum at 0·06 Å will produce ten developable grains. One hard gamma quantum renders 40 to 50 grains developable in either emulsion. A threshold value obtains and is defined as the energy loss per grain at the start of those electron traces where all grains hit have been rendered developable. This threshold is 1·9 keV (Non-Screen) and 2·2 keV (High-Speed) ionizing energy. Considerable loss is necessary if light of 4 250 Å is used. The X-ray sensitivity $\propto m^{2/3}$ (m = grain mass). The addition of $NH_4Au(SCN)_4$ to an emulsion hypersensitizes the film for both light and X-rays, the sensitization being wavelength-dependent. W. SUMMER

778.34 : 539.17

9901. A new apparatus for searching and measuring particle-sensitive plates. O. KOLB. Note in *Nuovo Cim.*, **8**, 487–90 (*July*, 1951) *In German.*

The mechanical stage of a microscope is modified so that the photographic plate can be reproducibly located, and the position of the field of view accurately measured. Manual or mechanical traversal is provided, and the tracks can either be viewed directly, or when projected. J. HUGHES

778.34 : 539.17

9902. Cylindrical emulsions. A. BONETTI AND G. P. S. OCCHIALINI. Note in *Nuovo Cim.*, **8**, 725–7 (*Sept.*, 1951).

The advantages of a type of nuclear emulsion on cylindrical support are described, and some of the possible applications are briefly discussed. A.

778.37 : 621.385.832 : 621.383.4

9903. The performance of image convertors as high-speed shutters. R. C. TURNOCK. *Proc. Instn Elect. Engrs, Pt II*, **98**, 635–41 (*Oct.*, 1951) [*Paper No.* 1178].

An image convertor has been used as a shutter mechanism for exposure durations of less than 1 microsec. The electron emission from the photocathode is controlled by suitable electrode potentials and the fluorescent image formed during the exposure interval is recorded photographically. The charac-

teristics of two types of image convertor are discussed, distortions which are peculiar to short exposure conditions are observed and an explanatory mechanism is suggested. The use of magnetic image deflection, whereby a line image may be given a deflection which varies with time, is also described, and streak records showing the variations in the object (along one dimension) as a function of time are discussed. A.

778.37 : 621.396.615.17 : 621.327.4

9904. A new power stroboscope for high-speed flash. W. D. CHESTERMAN, D. R. CLEGG, G. T. PECK AND A. J. MEADOWCROFT. *Proc. Instn Elect. Engrs*, **98**, *Pt II*, 619–33 (*Oct.*, 1951) [*Paper No.* 1127].

For abstract see Abstr. 4026 (1951).

778.534.8

9905. A 35 mm high-speed cinematograph camera. W. D. CHESTERMAN AND D. T. MYERS. *J. Sci. Instrum.*, **28**, 301–8 (*Oct.*, 1951).

A 35 mm high-speed cinematograph camera is described which takes full-size pictures at repetition rates from 100 to 2 000 per sec. Film capacity is 200 ft and films taken can be projected in the normal way. Optical compensation for the film movement during exposure is provided by a rotating cubical glass prism interposed between objective and film. For half-height pictures an octagonal glass prism is used and the maximum repetition rate is then 4 000 per sec. The instrument can be used with either continuous light on the subject or synchronized with the flashing light source of a high-speed power stroboscope. Removal of the image compensator permits the camera to be used as a high-speed film chronograph with a film transport speed of 125 ft/sec. Optical arrangements are made for the simultaneous photography of a cathode-ray oscillograph trace on part of the picture area. 1 000 c/s timing marks are given on the film edge. A.

778.6

9906. Quantitative estimation of the photographic effect on multi-layer colour-photography materials. YU. N. GOROKHOVSKIĬ, D. K. BALABUKHA AND T. M. LEVENBERG. *Dokl. Akad. Nauk, SSSR*, **79** (*No.* 1) 73–6 (1951) *In Russian.*

The author gives preference to the method of estimation based on the measurement of the surface concentrations of the 3 dyes in 3 elementary layers that together form the coloured field. If the dyes obey Bouguer's law $D_\lambda = k_\lambda cl$ (D_λ = optical density, c = surface concentration, l = thickness of the layer, which is const. in the present case), the following set of equations is obtained: $D_{\lambda 1} = k'_{\lambda 1}c' + k''_{\lambda 1}c'' + k'''_{\lambda 1}c'''$; $D_{\lambda 2} = k'_{\lambda 2}c' + k''_{\lambda 2}c'' + k'''_{\lambda 2}c'''$; $D_{\lambda 3} = k'_{\lambda 3}c' + k''_{\lambda 3}c'' + k'''_{\lambda 3}c'''$. The following wavelengths have been chosen for the determination of concentrations: $\lambda_1 = 440$, $\lambda_2 = 530$ (for both the negatives and positives), and $\lambda_3 = 790$ (for negatives) or 670 mμ (for positives). It has been found that Bouguer's law is strictly obeyed. Since it has not yet been possible to determine the absolute values of the absorption coefficients for each dye and for each wavelength, relative values have been adopted. It is suggested to adopt for the unitary relative surface concentration a concentration of each dye, such that the monochromatic optical density of the dye-carrying gelatine layer equals 1 for the maximum in the absorption curve. An example of calculation is given.

F. LACHMAN

778.6

9907. Diffusion phenomena in multi-layer colour-photography materials. K. MEYER AND H. ULBRICHT. *Z. wiss. Photogr.*, **46** (*No.* 4–6) 72–83 (1951) *In German.*

Presents results of a research carried out ten years ago. The experiments, relating to the diffusion of optical sensitizers, diffusion of components, and diffusion of the coupling oxidation product of the developer, have been confirmed by later investigations by various authors. F. LACHMAN

778.6

9908. Two instrumental aids for colour photography. H. E. J. NEUGEBAUER. *Z. wiss. Photogr.*, **46** (*No.* 4–6) 91–8 (1951) *In German.*

A new subjective photometer is described in which the comparison field is a diffusing screen lit by the general illumination. A photocell measures this general illumination to give exposure data. Filters may be interposed to give the blue : green : red ratio of the incident light. A slide-rule is described by which the appropriate colour filter may be selected.

R. W. FISH

AUTHOR INDEX—*continued*

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